TREK

METADATA

TUTORIAL

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1 Welcome

The Telescience Resource Kit (TReK) is a suite of software applications and libraries that can be used to monitor and control assets in space or on the ground. The TReK Metadata application provides the capability to create and manage telemetry and command metadata. This includes support for creating databases and metadata files and translating between different types of metadata formats.

This tutorial provides step-by-step instructions describing how to perform common application functions.

The topics in this tutorial require an understanding of the topics covered in the TReK Concepts document. Please be sure you have read the TReK Concepts document before proceeding with this tutorial.

This tutorial uses screen dumps taken on a Windows computer. However, the steps are the same regardless of whether you are running on Windows or Linux.

2 Technical Support

If you are having trouble installing the TReK software or using any of the TReK software, please contact us for technical assistance:

TReK Help Desk E-Mail, Phone & Fax:

E-Mail: trek.help@nasa.gov
Telephone: 256-544-3521 (8:00 a.m. - 4:00 p.m. Central Time)
Fax: 256-544-9353

If you call the TReK Help Desk and you get a recording please leave a message and someone will return your call. E-mail is the preferred contact method for help. The e-mail message is automatically forwarded to the TReK developers and helps cut the response time. The HOSC Help Desk (256-544-5066) can provide assistance as needed and is available 24x7.

3 Introduction

The TReK Metadata application provides the capability to create and manage telemetry and command metadata. This includes support for creating databases and metadata files and translating between different types of metadata formats. For a more detailed introduction to TReK metadata please reference the TReK Concepts document.

Packets are most often the data that are sent from one system to another system. Commands and telemetry are just packets. Command data is packets that tell another

system to do something. Telemetry data is packets that supply information about the system sending the packet.

Parameters are the individual data values that contain information about the state of the sending system or actions to be taken by the receiving system. Parameters have a value and are either placed in the outgoing data or pulled from the incoming data. TReK uses the terms "build" to describe placing parameters in a packet and "extract" to describe pulling parameters from a packet.

Parameters are grouped with related parameters into collections named parameter collections. Parameter collections are the basic building blocks of packets which are the data sent from one system to another. Figure 3 has four views of the same packet. The first row shows a packet as a single entity that could be sent between systems. The second row shows that the packet is composed of parameter collections and another packet. The third row shows that eventually a packet will break down into a series of parameter collections. The final row shows that all parameter collections are a series of parameters. Each row is a different view of the same data.

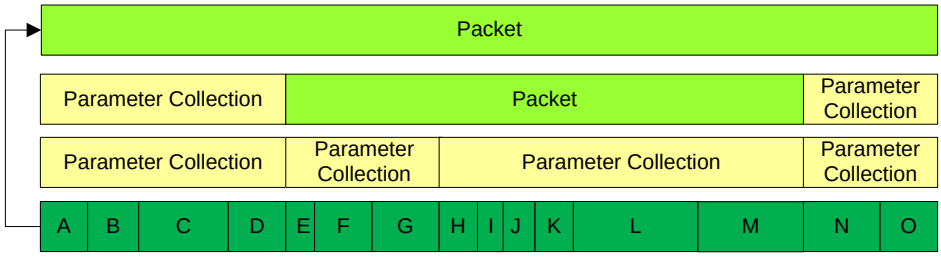

Figure 1 Packets, Parameter Collections, and Parameters

As mentioned earlier, Packets are the data that travel between systems. The packet is the largest aggregation of data in TReK.

Packets are divided into three zones: header, data, and trailer. One or more zones must be defined in a packet for it to be considered valid. Figure 2 shows each of the three zones and their relative locations. Each zone of a packet contains either another packet or a parameter collection.

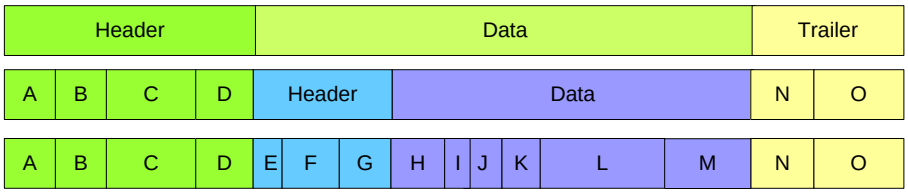

Figure 2 A Packet and Its Zones

The first line in the figure above shows a packet that has all three zones defined. The second level shows that the header and trailer zone are composed of parameter collections which contain one or more parameters. The data zone is composed of another

packet which only has the header and data zones defined. The third line shows that the packet in the data zone of the top level packet is composed of two parameter collections and that all of the data in a packet will eventually break down into a series of parameters.

The Metadata application provides the capability to create and modify a telemetry packet or a command packet. The application provides all the support needed to define the details for a Packet, Parameter Collection, and Parameters like those shown in Figure 1 and Figure 2. Once defined these packet definitions can then be used with various TReK applications to monitor and control an asset in space or on the ground.

Since there are many different ways to format metadata, TReK supports a variety of formats as described below.

C Programming Language Header File
Many software developers represent a packet definition using a C structure defined in a C header file. TReK can import the packet definition by reading the C structure defined in a C header file.

Common Data Exchange Format (CDEF)
CDEF is an International Space Station (ISS) program format that contains metadata described using XML. It is used to exchange telemetry and command information between data systems.

TReK Database
A TReK database is a SQLite database that can contain metadata information for one or more packets.

TReK Metadata File
This is a TReK generated file that contains metadata described using XML (e.g. a Packet definition, a Parameter Collection definition).

The Metadata application can read, write, and translate between these different types of formats.

The Metadata application also provides the capability to import metadata information obtained from the HOSC including metadata defined in Partial Database Download Files and Ground Support Equipment (GSE) packet definitions.

4 Overview of the User Interface

4.1 Main Window

The main window contains several areas as shown in Figure 3. The Toolbar contains multiple buttons that reconfigure the main window to focus on a specific metadata element such as a Parameter Collection or a Packet.

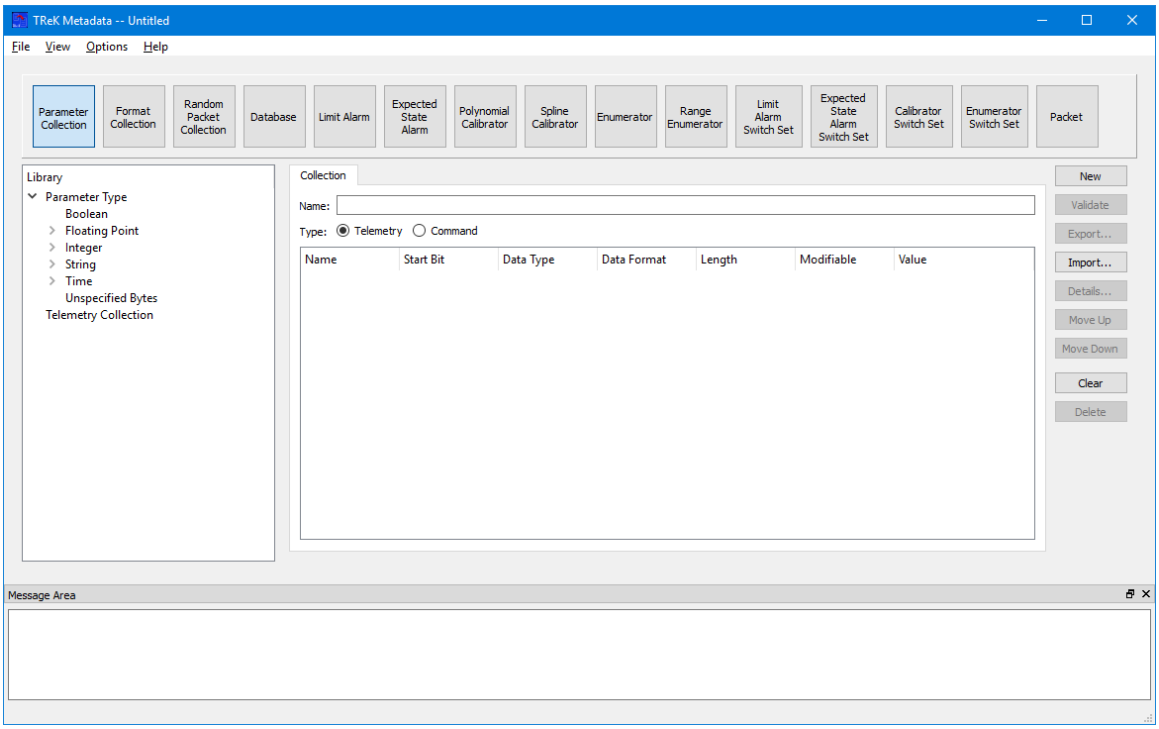

Figure 3 Main Window

Toolbar

The toolbar at the top of the window provides quick access to configure the main window to work on a specific metadata element such as a packet or a parameter collection.

Library Area

The Library Area is context sensitive and will be reconfigured to support the specific area you are working on. For example, if you are creating a Parameter Collection, the Library Area will be configured to show a list of all the types of parameters that you can add to a parameter collection. If you are working on a Database, the Library will be configured to show you a list of databases that are available for you to interact with.

Work Area

The Work Area is context sensitive and will be reconfigured to support the specific type of element you are working on. If you are working on a Parameter Collection, the Work Area will display the Parameter Collection content. If you are working on a Database, the Work Area will display the list of packets in the Database you have selected to work with. If you are working on a Limit Alarm, the Work Area will display the content of the Limit Alarm. If you are working on a Packet, the Work Area will display the contents of the packet. The Work Area provides the capability to create or modify the contents of a specific element.

Button Area

The Button Area is context sensitive and will be reconfigured to display functions available for the specific area you are working on. For example, if you are working on a Parameter Collection, you would have functions available such as creating a New Parameter Collection, Validating a Parameter Collection, Exporting the Parameter Collection (saving it in a file in a specified format), Importing a Parameter Collection (reading it from a file in a specified format), modifying the order of parameters in the collection by moving them up and down in the list, and deleting a parameter in the collection.

Message Area

The Message Area displays important status and error messages. The message area can be cleared using the View menu. The Message Area is a dock window that you can float or dock. To float a dock window, use your left mouse button to click and hold the title area while dragging the window to another area of the screen. To dock, use the title bar to drag the dock window over the main window and drop.

4.2 Toolbar

The Toolbar contains multiple buttons that reconfigure the main window to focus on a specific metadata element such as a Parameter Collection, a Database, a Limit Alarm, or a Packet.

5 TReK Metadata Tour

Sometimes it's easier to learn how to use an application by example. This section describes how to use the Metadata application to create a Telemetry Packet definition and then use it with the TReK Data application to receive and process telemetry data that matches that packet definition. Figure 4 shows the structure of the Telemetry Packet to be defined.

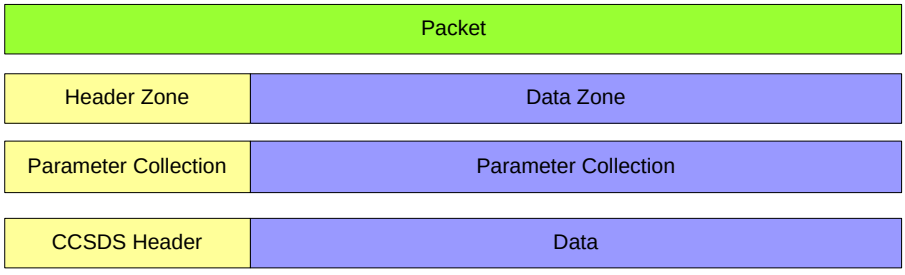

Figure 4 Tutorial Telemetry Packet

This packet contains a Header Zone and a Data Zone. Each zone contains a parameter collection. The final product will be a packet with a CCSDS Header in the Header Zone and a Custom Parameter Collection in the Data Zone. Most programs select a standard header (e.g. CCSDS), or define a custom header, that will be used on packets exchanged

between their flight and ground systems. So it is common to create multiple packets that all have the same header zone, but contain different data zones.

Step-by-Step instructions are divided into the following sections:

- Create a Parameter Collection – this section shows how to create a custom parameter collection that will serve as the Data Zone of the Packet

- Create a Packet – this section shows how to use a packet template to create a telemetry packet and then add the custom Parameter Collection to the Data Zone.

- Packet Data Flow – this section shows how you can use the packet definition you created with the TReK Data application to receive and process packets that match the packet definition.

Note: The Packet Data Flow step of this tutorial requires the use of TReK 3.1.3. If you do not have TReK 3.1.3, please download this software from the TReK Web Site and install it on a Windows computer (Win7 or Win10) to perform the steps in this section.

This section was written assuming you have read the Introduction section and the Main Window section. If you have not read these sections, please go back and read them. They contain important information that is not repeated in this section.

If at any time you need to exit the application so you can resume working through the Tutorial at a later time, File Save will allow you to save all the data you entered.

Please go through the tour in order. Some sections depend on data from previous sections.

Create a Parameter Collection

5.1 Create a Parameter Collection

The first step in creating the Telemetry Packet definition is to create a Parameter Collection to serve as the Data Zone. The following steps describe how to create a Parameter Collection. Let's look once again at the packet you are going to define. It is shown in Figure 5 below.

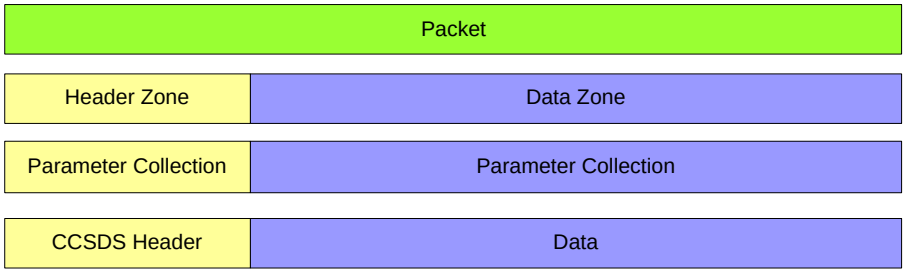

Figure 5 Tutorial Telemetry Packet

The Parameter Collection in the Data Zone will contain the following parameters as shown in Table 1 below.

Parameter	Start Bit	Data Type	Total Length
UINT_16	0	Unsigned Integer	16 (2)
INT_32	16	Sign and Magnitude Integer	32 (4)
FEEE_64	48	Floating Point	64 (8)
SUND_80	112	Undefined String	80 (10)

Table 1 Data Zone Parameters

Step-By-Step

1. If you haven't started the Metadata Application, use the operating system's menu to start the application. You should see the Metadata main window shown in Figure 6.

   The Main Window initializes with the Collection work area as the default. On the left hand side of the Main Window you will see the Library Area. It is configured to provide access to items you can use to create a Parameter Collection. In the middle of the Main Window you will see the Work Area showing the Collection Tab. This is where you will define the details of your Parameter Collection. On the right hand side of the Main Window you will see a list of buttons that provide various capabilities applicable to the Parameter Collection you are working on (e.g. Validating the Parameter Collection and Exporting the Parameter Collection).

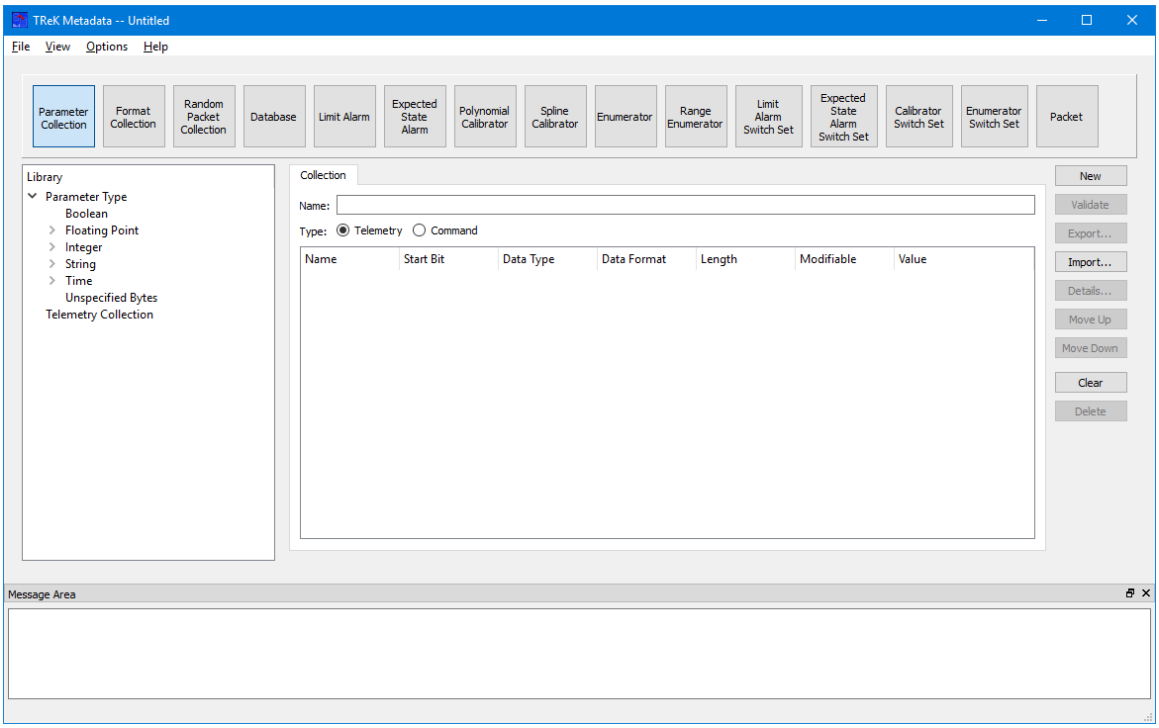

Figure 6 Metadata Main Window

2. Start by entering a name for the Parameter Collection. In the Name field enter **Science Data**. After completing this step, the Main Window should look like the one shown in Figure 7.

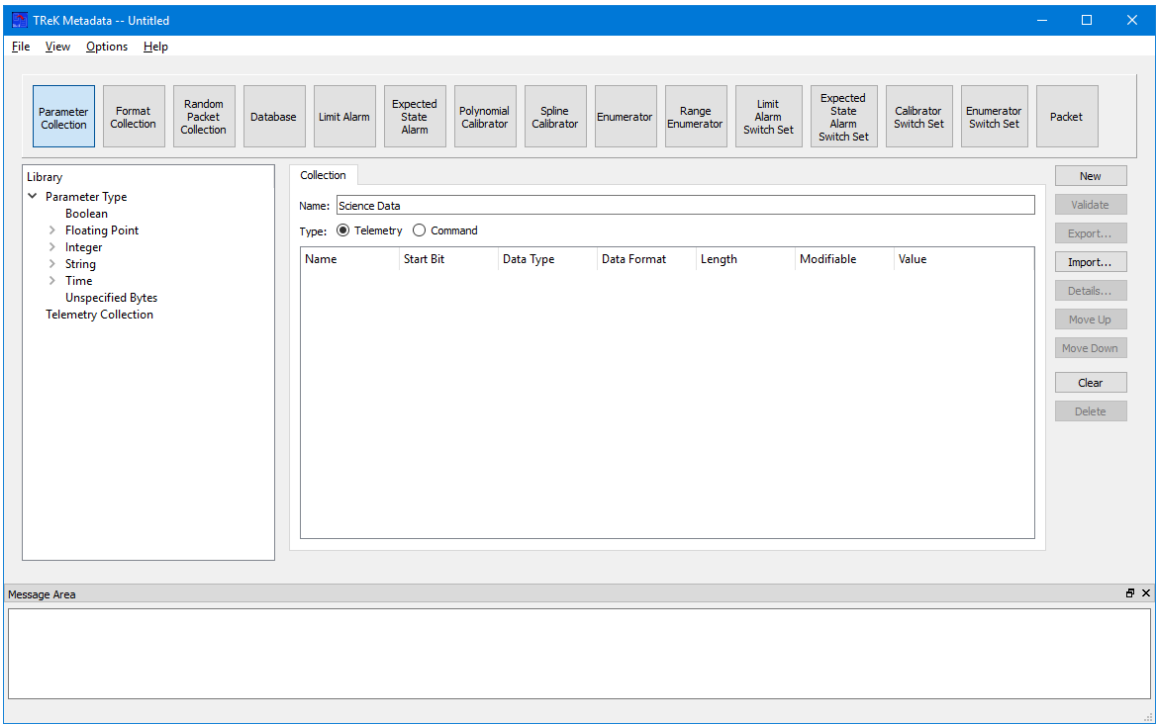

Figure 7 Parameter Collection Name - Science Data

3. Since you are creating a Telemetry Collection you need to ensure the Telemetry radio button is selected as shown in Figure 7.

4. The next step is to start adding parameters to the Parameter Collection. There are four parameters you need to add to the Parameter Collection. The Metadata application uses Drag and Drop to move items from the Library Area into the Work Area. The first parameter you need to add to the Parameter Collection is a 16 bit unsigned integer. Go to the Library Area and click on the Integer item in the list so it expands as shown in Figure 8.

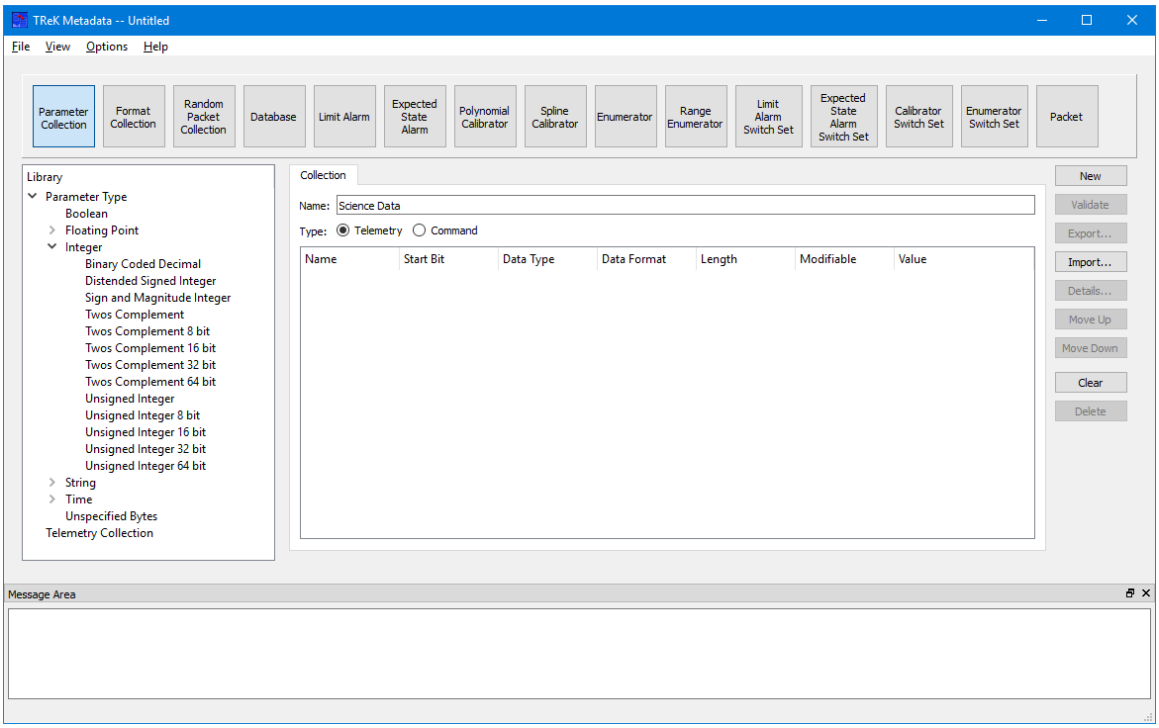

Figure 8 Library Area Showing Integer Expanded

5. Use your left mouse button to select the Unsigned Integer 16 bit item in the list, and while holding the left mouse button down, drag the item to the Work Area and drop it as shown by the green arrows in Figure 9. After dropping you should see the parameter in the list as shown in Figure 10.

Collection Drag and Drop Tips and Tricks

- If you drop an item anywhere on the list it will be placed at the end of the list.
- If you drop an item on top of another item, the item will be placed below that item in the list.
- If you drag an item using the right mouse button, a dialog will pop up asking how many of that item you would like to add to the list [This feature is only available on Windows].

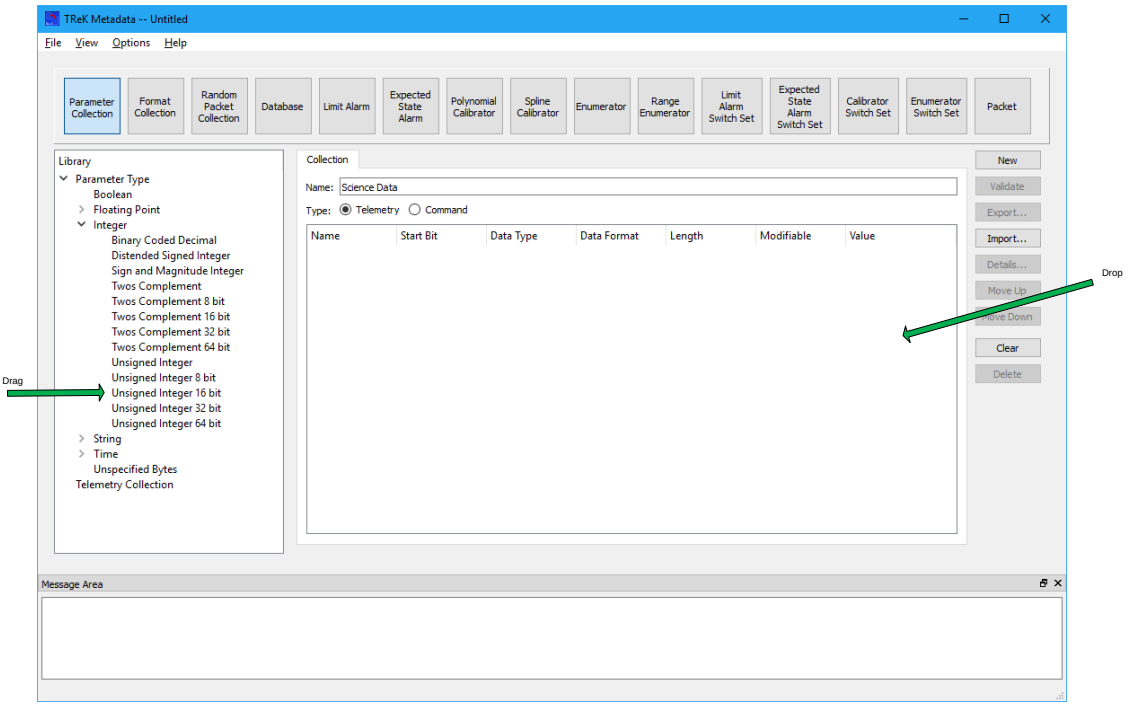

Figure 9 Drag and Drop Areas for 16 Bit Unsigned Integer Parameter

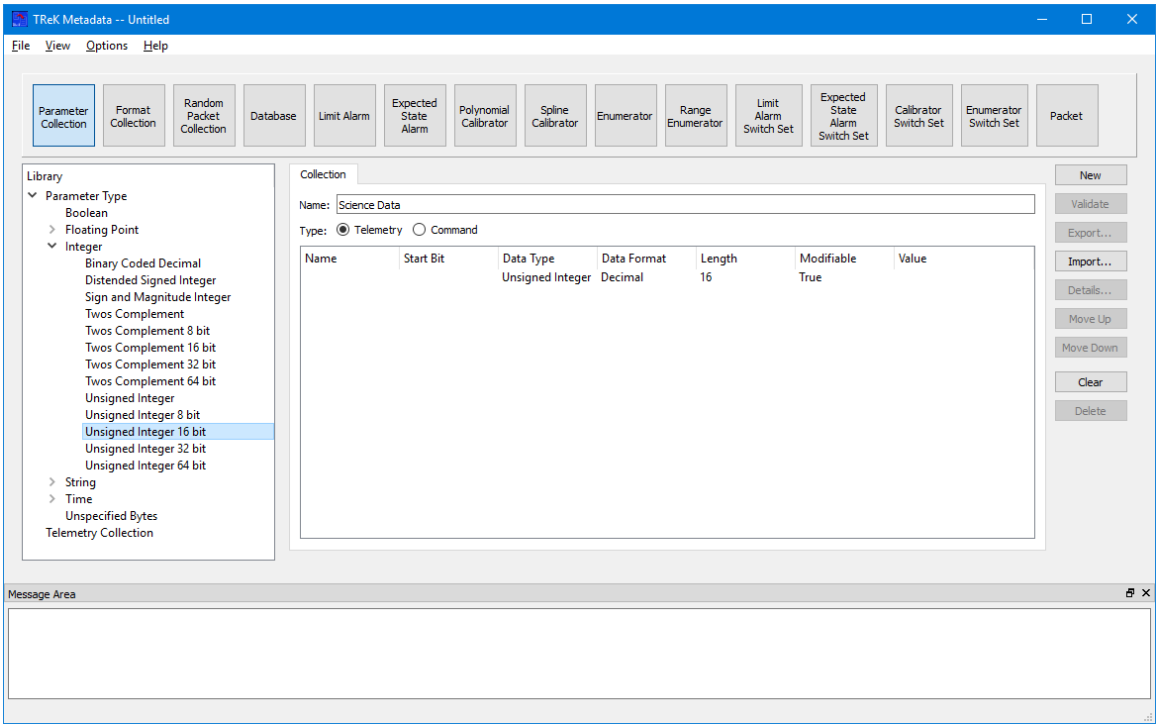

Figure 10 16 Bit Unsigned Integer Parameter in List

6. Now you need to fill in the information for the Parameter. Use your left mouse button to double click in the Name cell of the row in the list and then enter the name UINT_16. When you are finished it should look like Figure 11.

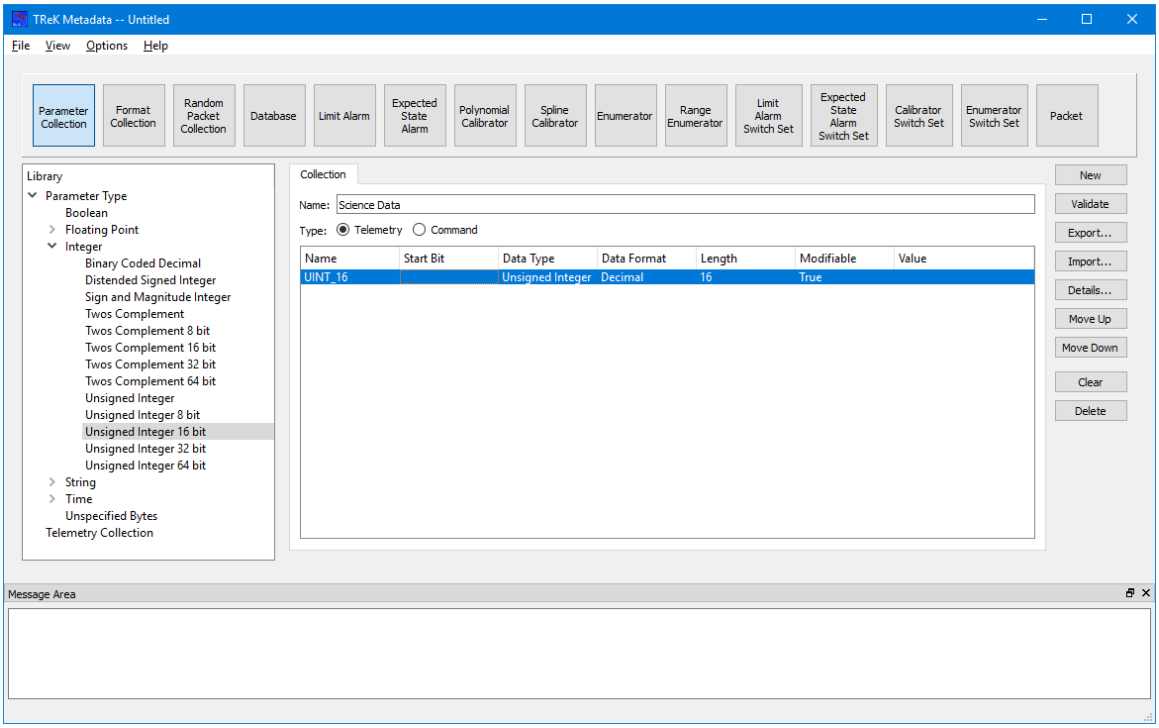

Figure 11 UINT_16 Parameter Updated with Name

Note: If the columns are not wide enough to display the text in the column, you can resize the columns by dragging the vertical bar next to the column name.

7. The next item to fill in is the Start Bit. Since this is the first parameter in the Parameter Collection, enter 0 for the Start Bit as shown in Figure 12.

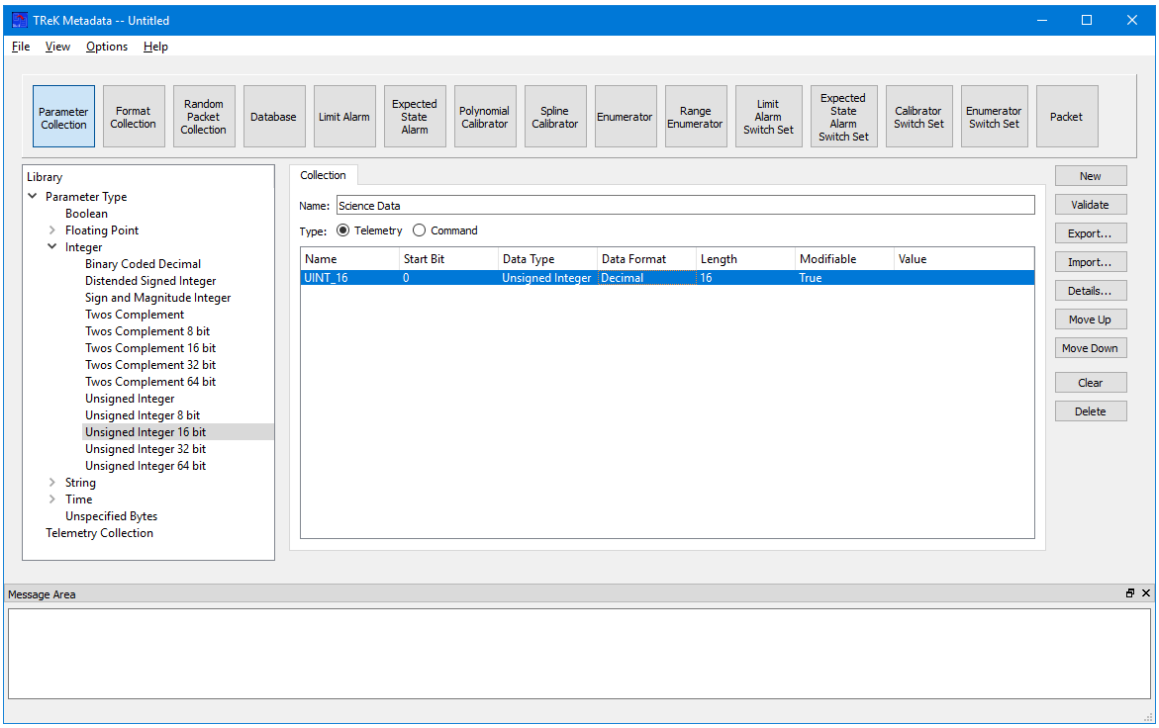

Figure 12 Start Bit of 0

You have now completed entering the first parameter in the Parameter Collection. Now you need to perform the same steps for each of the remaining three parameters.

8. Notice that the Data Type, Data Format, and Length columns are already filled in for you. This is because you selected a specific parameter type from the Library that had a predefined length. A telemetry parameter is always considered modifiable. Since you are defining a telemetry packet, there is no need to specify a value. It will be extracted from the telemetry packet.

9. The second parameter in the list is a 32 bit Sign and Magnitude Integer. Find the Sign and Magnitude Integer in the Library and drag and drop it into the list. Depending on where you drop it in the list the item may end up as the first item in the list instead of the second item in the list. No worries. Just select the 32 bit Sign and Magnitude Integer in the list, and push the Move Down button to move it to the second position in the list. The Main Window should look like the one in Figure 13.

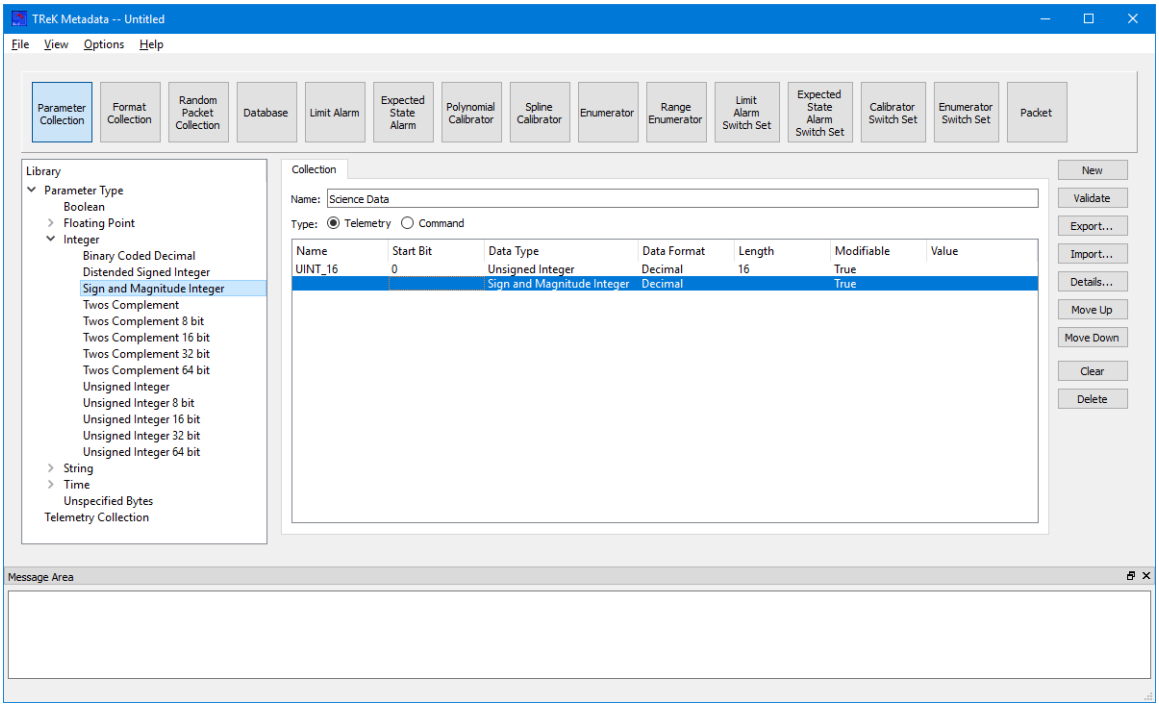

Figure 13 Sign and Magnitude Integer

10. As before, edit the row to enter the name (INT_32), the Start Bit (16), and the Length (32). Once you are done your list should look like the one in Figure 14.

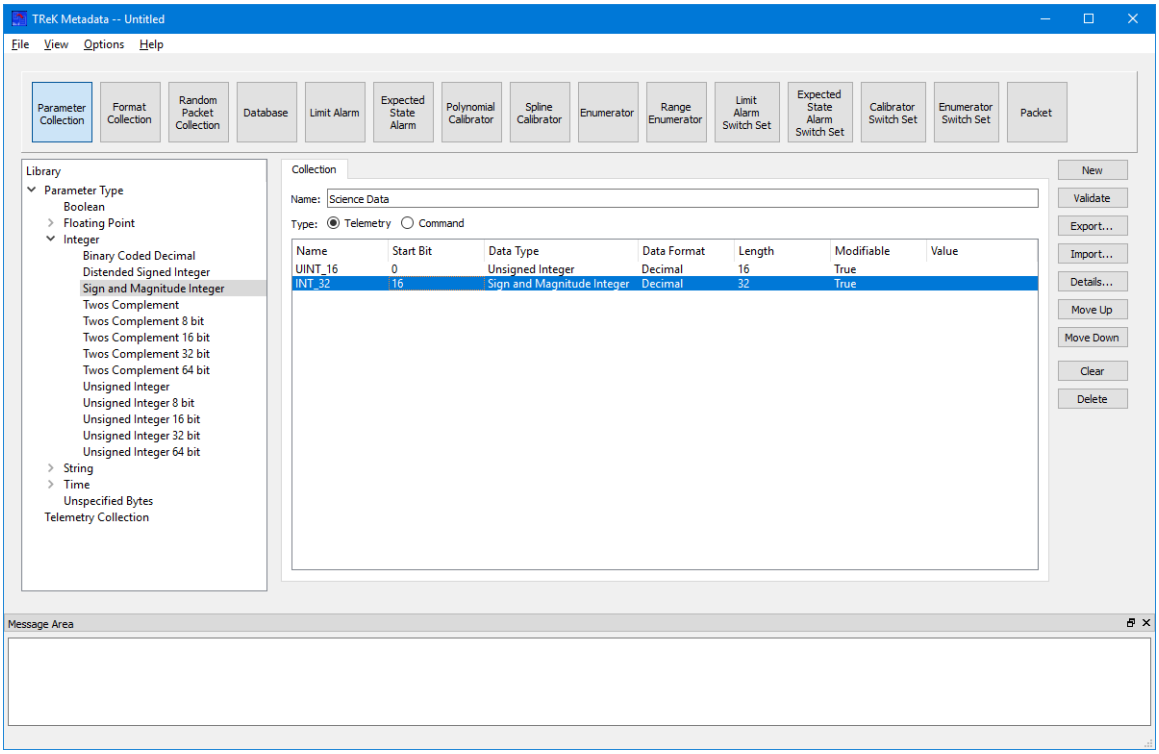

Figure 14 Sign and Magnitude Parameter

11. The third parameter in the list is a 64 bit Floating Point parameter. Expand the Floating Point item and look for 64 bit IEEE Floating Point item. Drag and drop the item in the list and edit the row to enter the name (FEEE_64) and the start bit (48). The Main Window should look like the one in Figure 15.

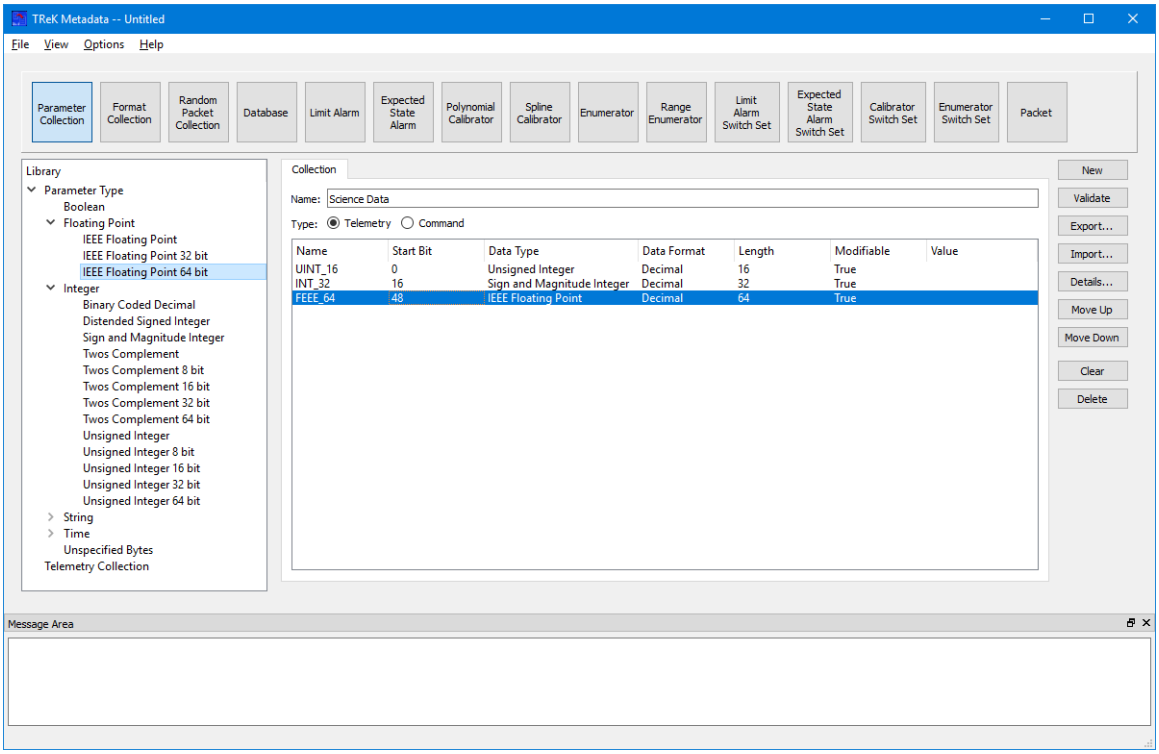

Figure 15 IEEE Floating Point Parameter

12. The fourth parameter in the list is an undefined string that is 80 bits (10 bytes) long. Find the Unspecified Bytes parameter and drag and drop it in the list. Edit the row to enter the name (SUND_80), the start bit (112), and the length (80). The Main Window should look like the one in Figure 16.

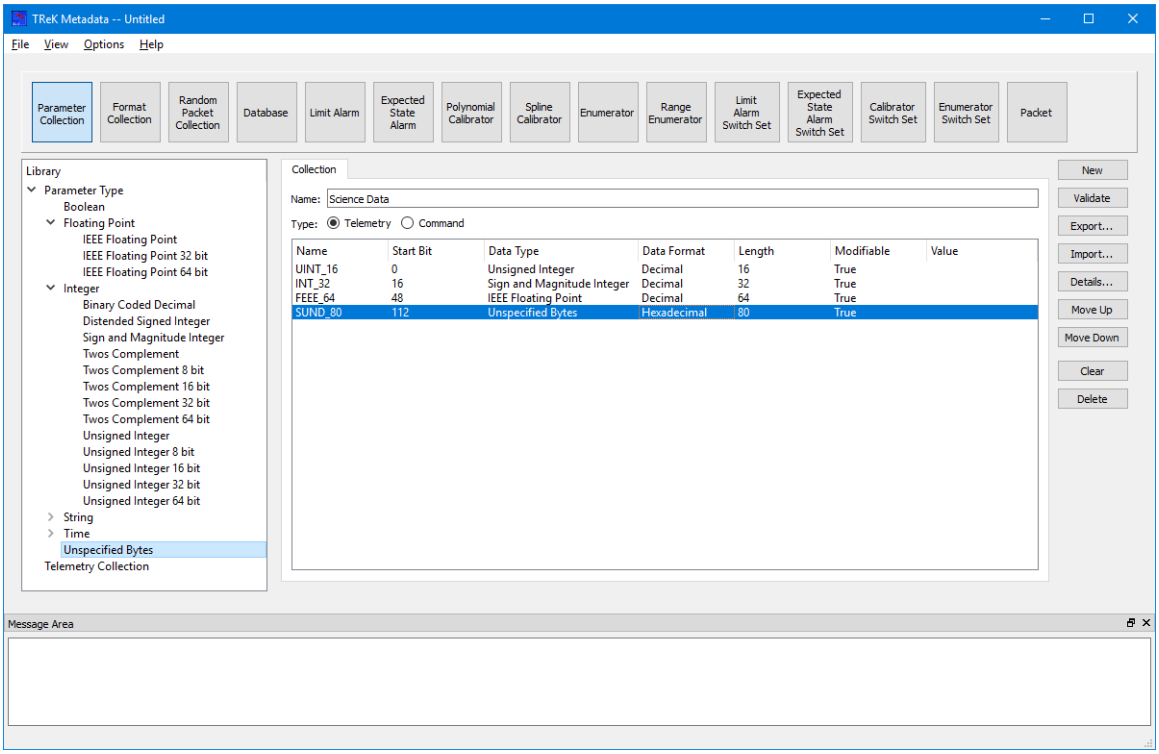

Figure 16 Undefined String Parameter

13. In order to use the new Parameter Collection in a packet, you need to export the Parameter Collection so it is saved in a file. Before you export it is always a good idea to validate to be sure everything is correct. Push the Validate button. You should see a dialog similar to the one shown in Figure 17.

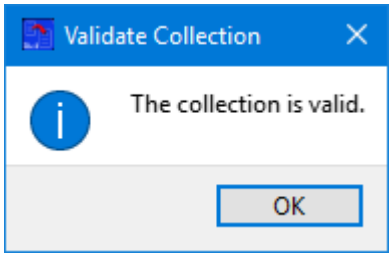

Figure 17 Validate Collection Dialog

Note: If there are errors, please check your entries to be sure they match the information in the tutorial.

14. Now that you know the collection is valid, push the Export button to export the Parameter Collection. You should see the dialog shown in Figure 18. Notice that the Filename defaults to the collection name and the default location is the telemetry_collection directory in the trek_workspace.

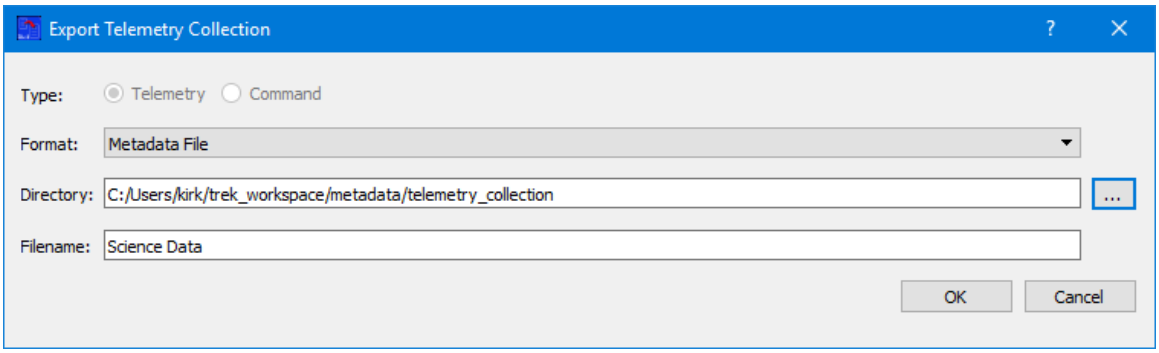

Figure 18 Export Telemetry Collection Dialog

15. In the Export Collection dialog, push the OK button to perform the Export. You should see the message in Figure 19. Push the OK button in the message dialog and both the message dialog and the Export dialog will close. Once the Export dialog closes a message will appear in the Main Window message area and the Science Data collection will be listed in the Telemetry Collection list in the Library Area.

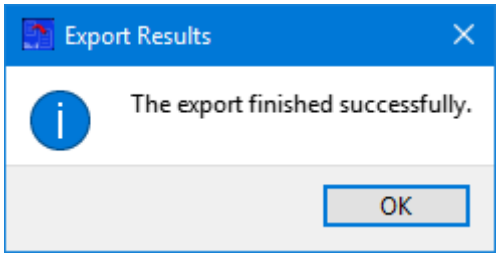

Figure 19 Export Successful Message

Congratulations – you have successfully created your first Parameter Collection.

Create a Packet

5.2 Create a Packet

This section will cover how to create a packet. If you haven't moved to the Packet tab yet, please push the **Packet** button in the Main Window toolbar so your Main Window looks like the one in Figure 20.

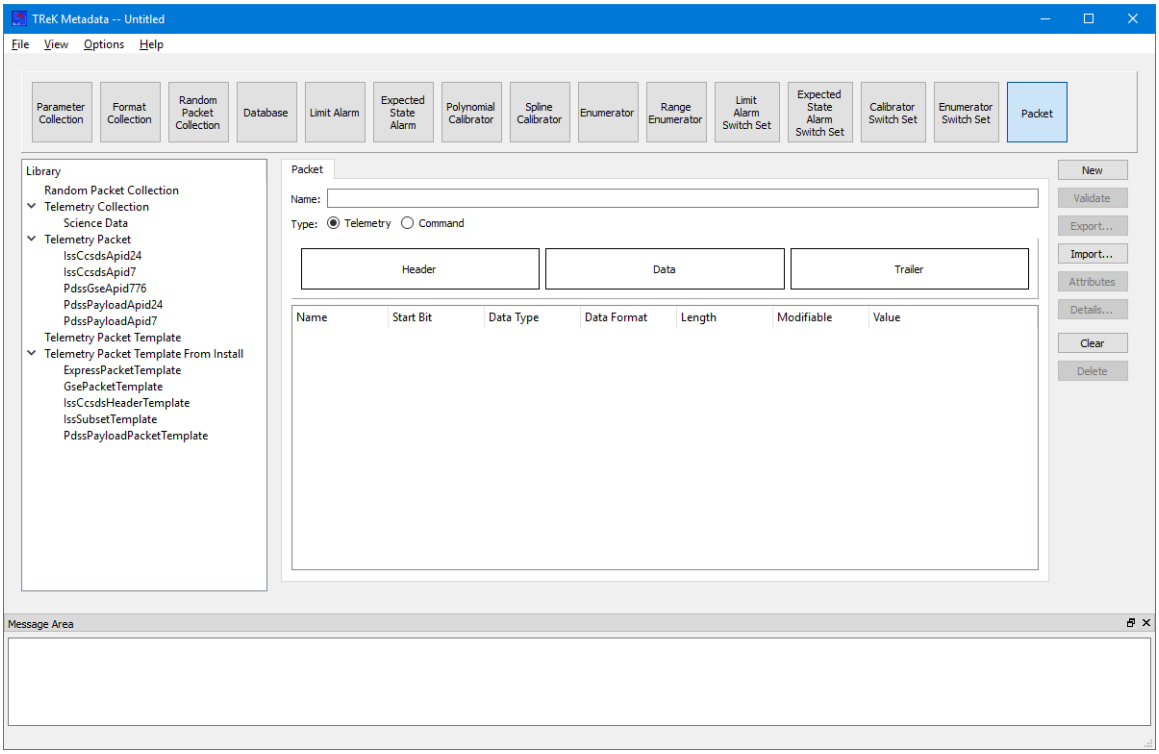

Figure 20 Main Window with Packet Selected

As shown in Figure 21, the goal of this tutorial is to create a CCSDS packet. A CCSDS Packet has a CCSDS Header and a specific set of Packet Attributes. You could create the packet from scratch. However, it is much easier to use a packet template and save yourself some work. TReK provides a set of predefined packet templates. These are listed under Telemetry Packet Template From Install and Command Packet Template From Install. A packet template is a packet that includes pre-populated zones and packet attributes corresponding to the specific type of packet. For example, a CCSDS packet template contains a CCSDS Header and the following packet attributes: a Counter parameter, an APID Identifier, a Length parameter, and a Timestamp Parameter. By using a template, you can start your packet definition with all that information already defined.

Figure 21 CCSDS Packet

The Main Window Library Area is configured to provide access to items you can use to create a packet. In the middle of the Main Window, the Packet tab provides a place to define the details of your packet. On the right hand side of the Main Window the buttons provide various capabilities applicable to the Packet you are working on.

Notice the rectangle that contains three smaller rectangles with one for each zone of the Packet (Header, Data, and Trailer) as shown in Figure 22.

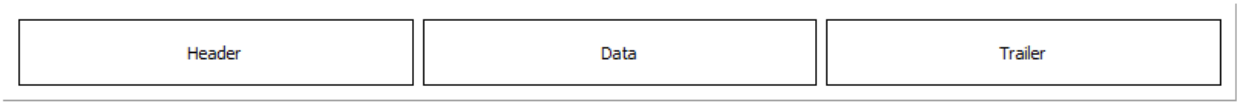

Figure 22 Packet Drop Zones

These rectangles are "Drop" zones. The large rectangle is a drop zone for the Entire Packet. If you drop a Packet Template or a Packet on the large rectangle, this will populate the entire Packet. If you drop a Packet or a Parameter Collection on one of the individual packet zones, that zone of the Packet will be updated. The drop zones will highlight so you can verify you are dropping the item in the correct location. Figure 23 shows what the "Entire Packet" drop zone looks like when it is highlighted. Figure 24 shows what the "Data Zone" drop zone looks like when it is highlighted.

Figure 23 Entire Packet Drop Zone Highlighted

Figure 24 Data Zone Drop Zone Highlighted

16. To get started, first enter **Science Packet** in the **Name** field as shown in Figure 25.

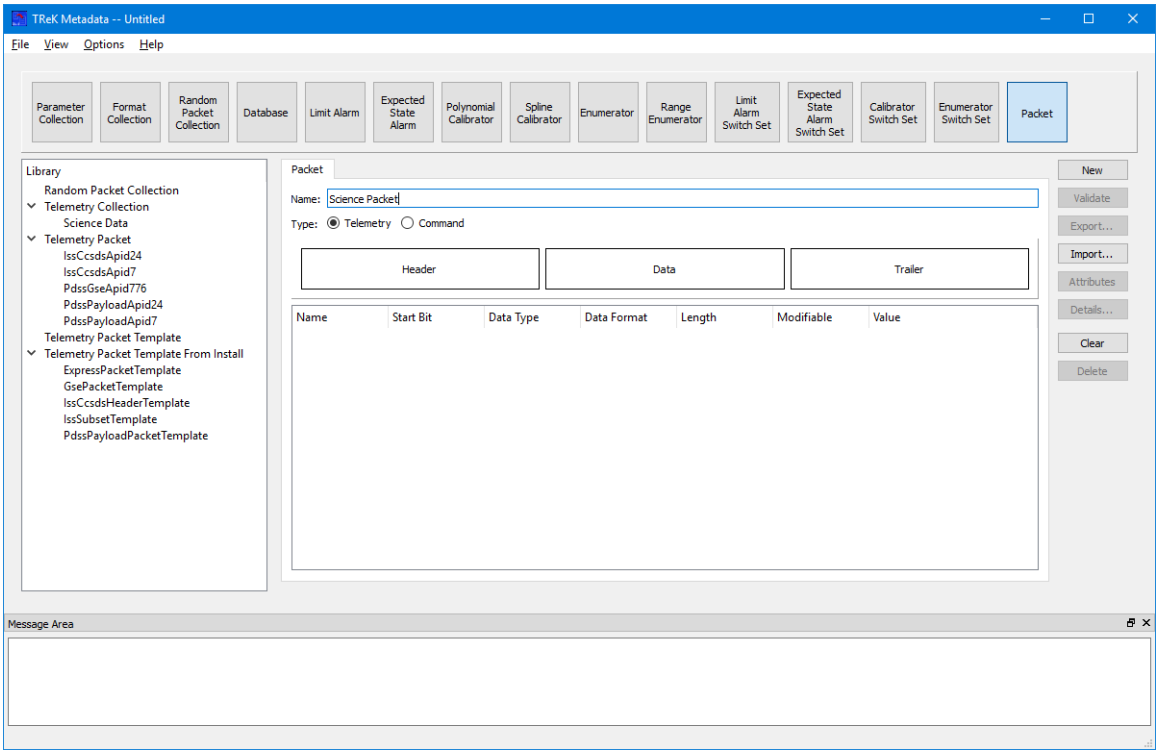

Figure 25 Packet Tab with Name Populated

17. Since the packet is a Telemetry Packet, ensure the Type is set to Telemetry as shown in Figure 25.

18. In the Library Area, ensure the Telemetry Packet Template From Install item is expanded to show the list of templates as shown Figure 26.

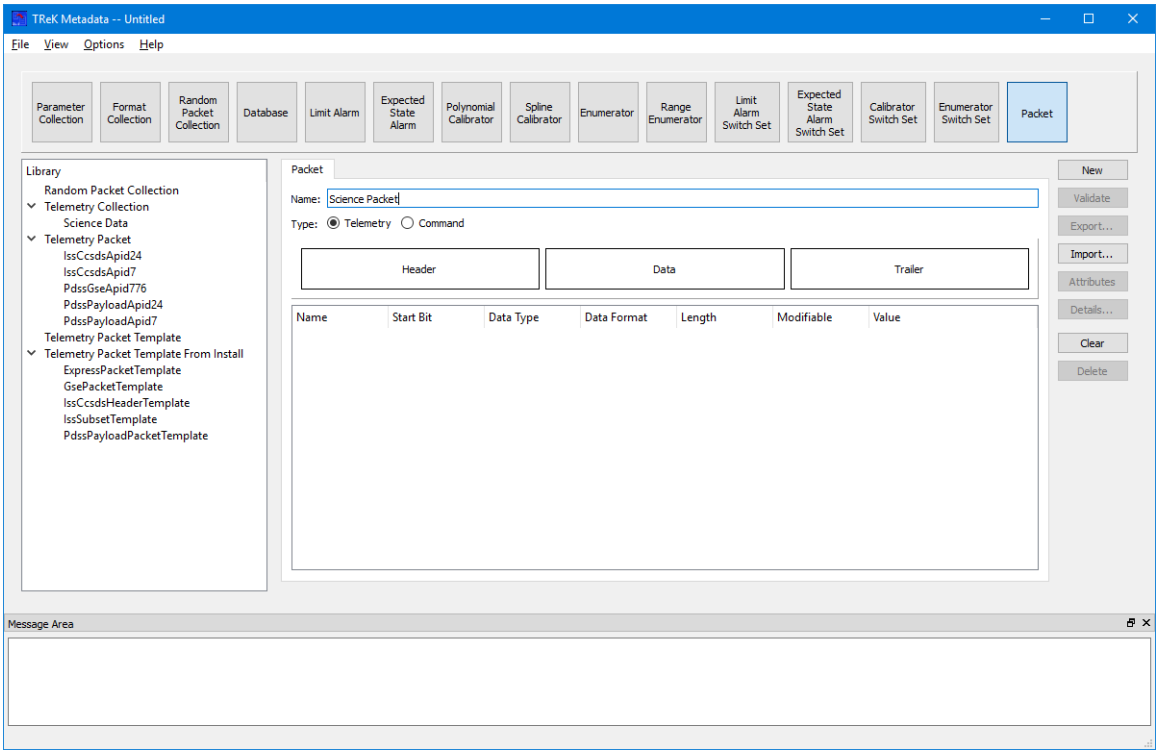

Figure 26 Telemetry Predefined Packet Template List Expanded

19. In the Library Area, you can see there are several "CCSDS" related packet templates. Sometimes programs start with a standard header and further customize it. For this tutorial, we will use the International Space Station program's CCSDS Header. Select the IssCcsdsHeaderTemplate item under the Telemetry Packet Template From Install list using your left mouse button. Hold the left mouse button down and drag the item into the large rectangle - you should see the large rectangle highlight to show you the drop zone as shown in Figure 27. Once you see the highlight release the mouse button to drop the item. Once you drop the item your Main Window should look like the one in Figure 28. You can now see you have a packet with a CCSDS Header.

    Note: If by chance it did not drop into the location you intended, you can push the **New** or **Clear** button to clear the packet and start over.

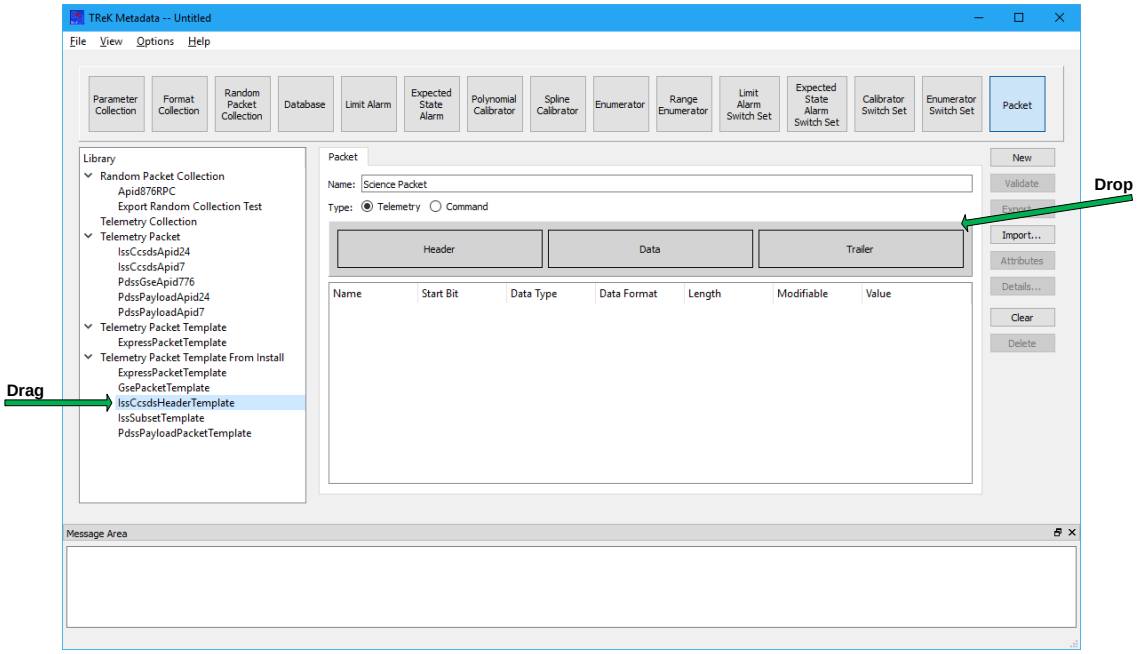

Figure 27 Entire Packet Drop Zone Highlighted

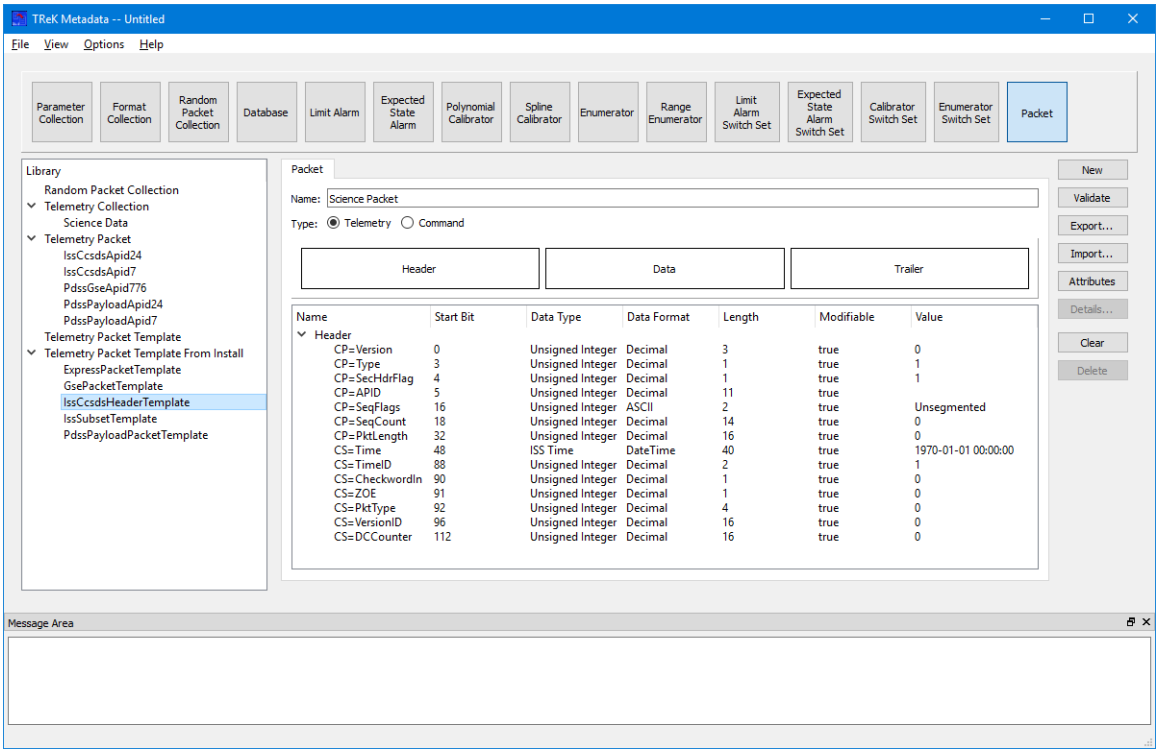

Figure 28 IssCcsdsHeaderTemplate Packet

20. To see that the Packet Attributes are already defined by the Packet template, push the **Attributes** button to display the **Packet Attributes dialog** as shown in Figure 29. The IssCcsdsHeader packet does not have a Checksum parameter so it is not defined. However, if you look at the other tabs in the dialog, you will see it does have a Counter parameter, an APID identifier, a Length parameter, and a Timestamp parameter. There is no need to make any changes to this information so push the Cancel button to close the Packet Attributes dialog without making any changes.

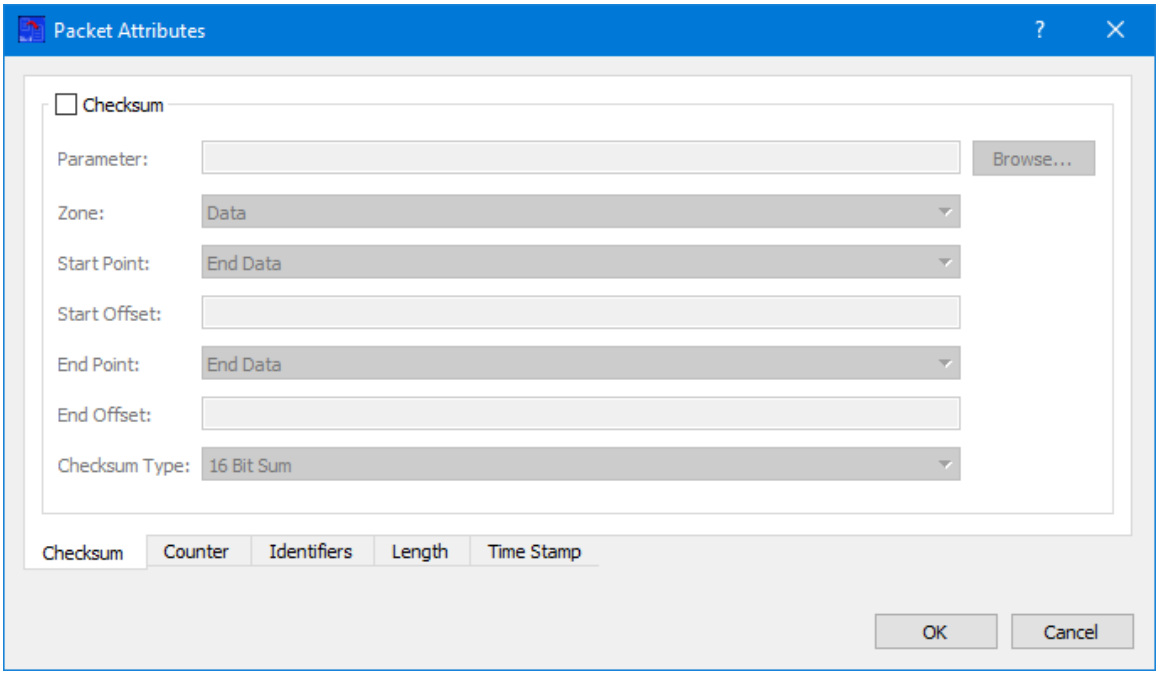

Figure 29 Packet Attributes Dialog

21. Now it's time to add the Science Data collection you created in the Data Zone of the packet. In the Library Area, be sure the Telemetry Collection item is expanded so you can see the list as shown in Figure 30.

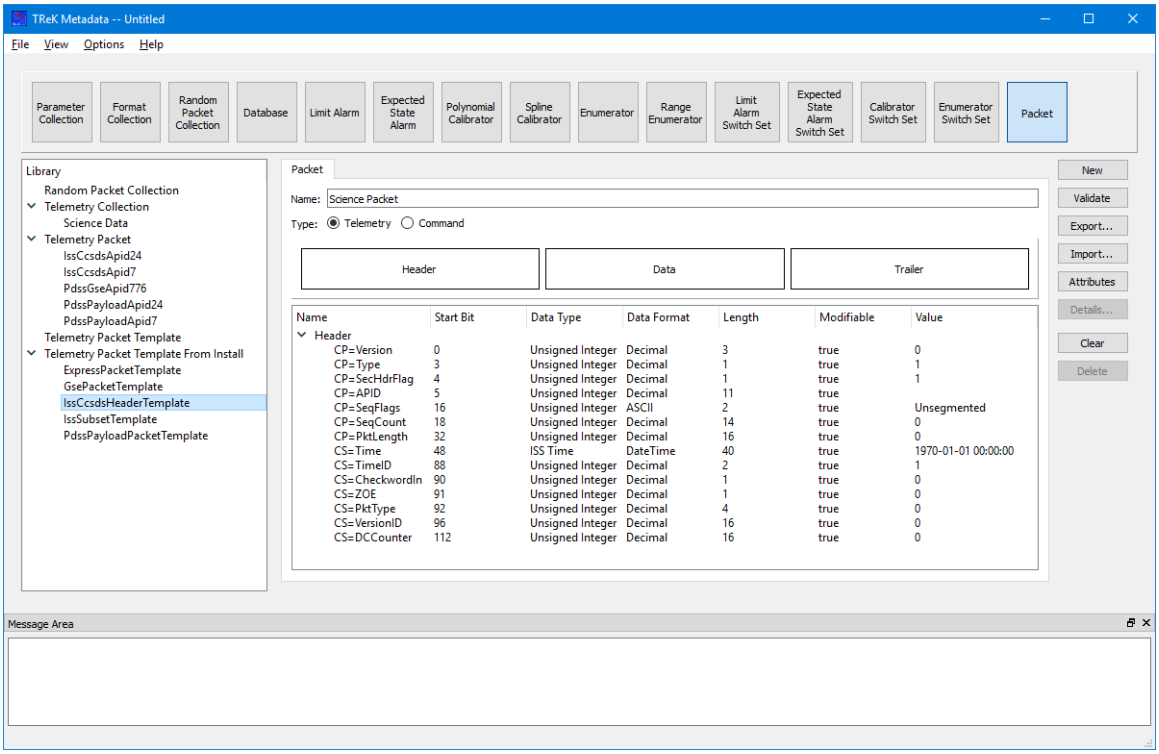

Figure 30 Telemetry Collection List Expanded

22. In the Library Area, select the Science Data item and drag and drop it over the "Data" Drop Zone. Remember to look for the Data rectangle to highlight so you know that you are dropping it in the right location. Your Main Window should look like the one in Figure 31.

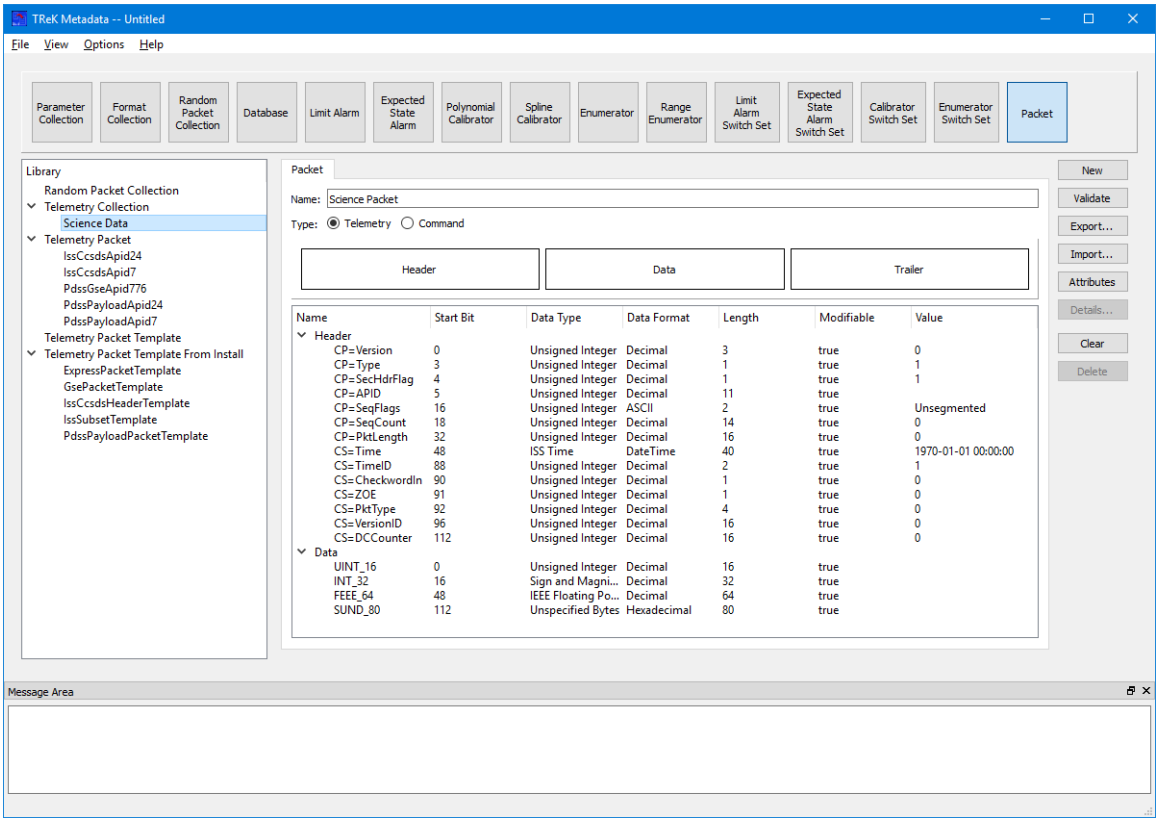

Figure 31 Science Data Collection in Data Zone

23. There is one more step to finish the packet definition. Since this is a unique packet definition, you will set the CCSDS Application Identifier (APID) to give the packet a unique number. The **APID** parameter is the fourth parameter in the list of parameters in the Header. Double click in the **Value** cell of the **APID** row and enter the number **314**. Your Main Window should look like the one shown in Figure 32.

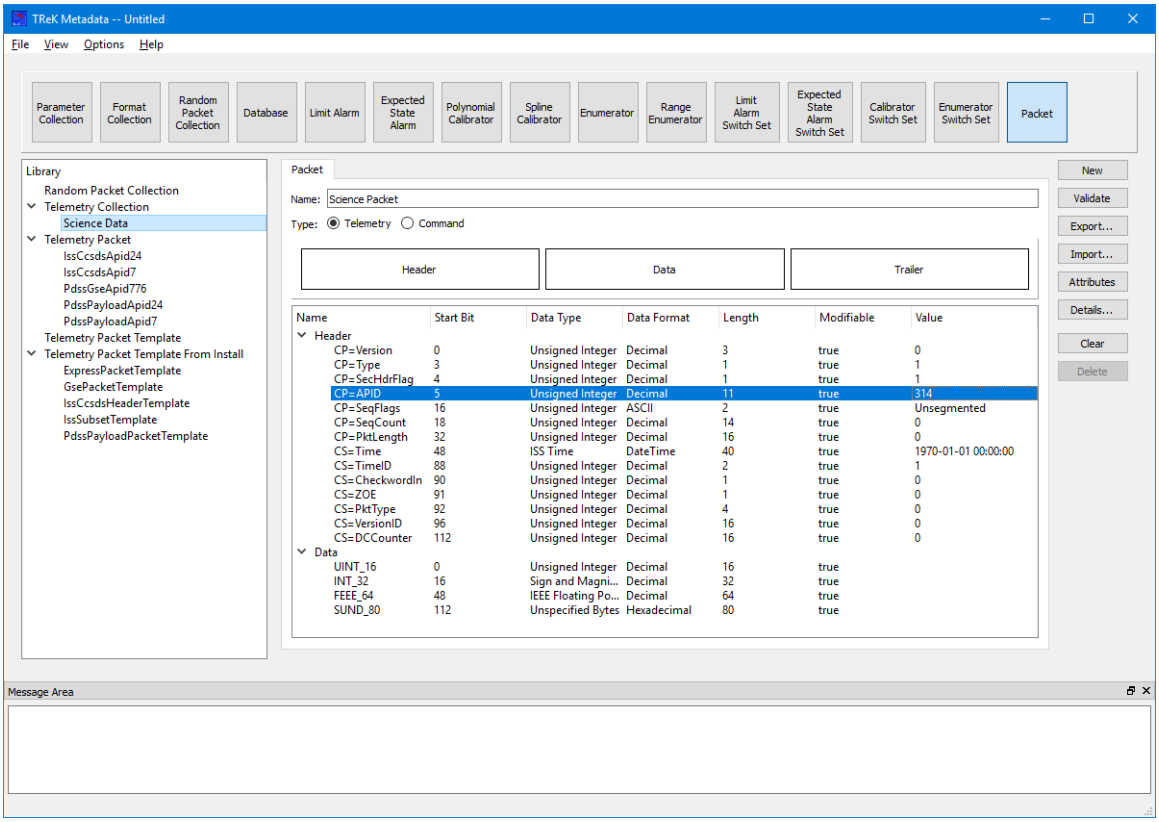

Figure 32 Packet with APID Value Set to 314

24. As before, it is always a good idea to Validate your packet definition. Push the **Validate** button and you should see the Validate dialog as shown in Figure 33.

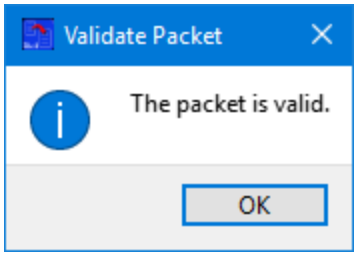

Figure 33 Packet Validate Dialog

25. Now that you know the packet is valid, push the Export button to export the Packet. You should see the dialog shown in shown in Figure 34. Notice that the filename defaults to the packet name and the directory defaults to the telemetry_packet directory in the trek_workspace.

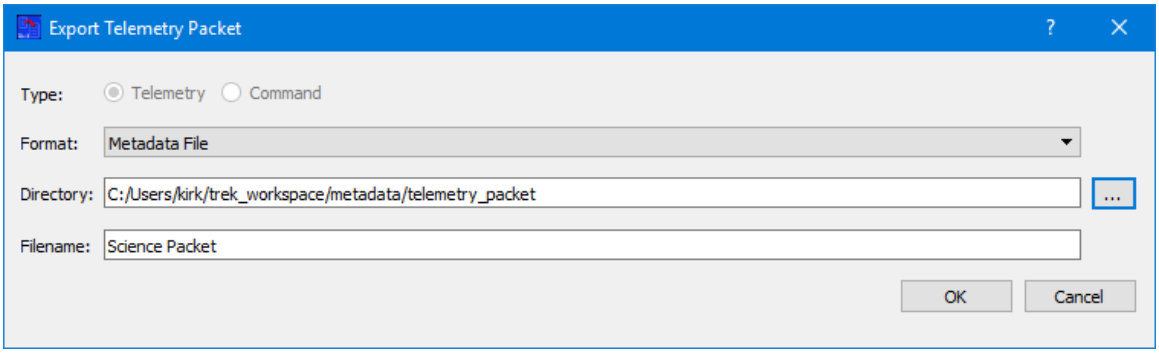

Figure 34 Export Telemetry Packet Dialog

.

26. In the Export Packet dialog, push the OK button to perform the Export. You should see the Export Results message dialog showing the export was successful. Push the OK button to close the Export Results message and the Export dialog. Once the Export dialog closes you should see a message in the Main Window indicating the export was successful and the Science Packet will be listed in the Telemetry Packet list in the Library Area.

Congratulations – you have successfully created your first Packet!

You have completed all the tasks you need to perform with the Metadata Application so you can exit the application. You don't need to save the configuration since you have exported all changes to the disk.

Packet Data Flow

5.3 Packet Data Flow

This section will show you how you can use the packet definition you created with the TReK Data application to receive and process Packet 314 data.

27. Go to the operating system's menu to start the **TReK Data** application. You should see the **TReK Data** main window shown in Figure 35.

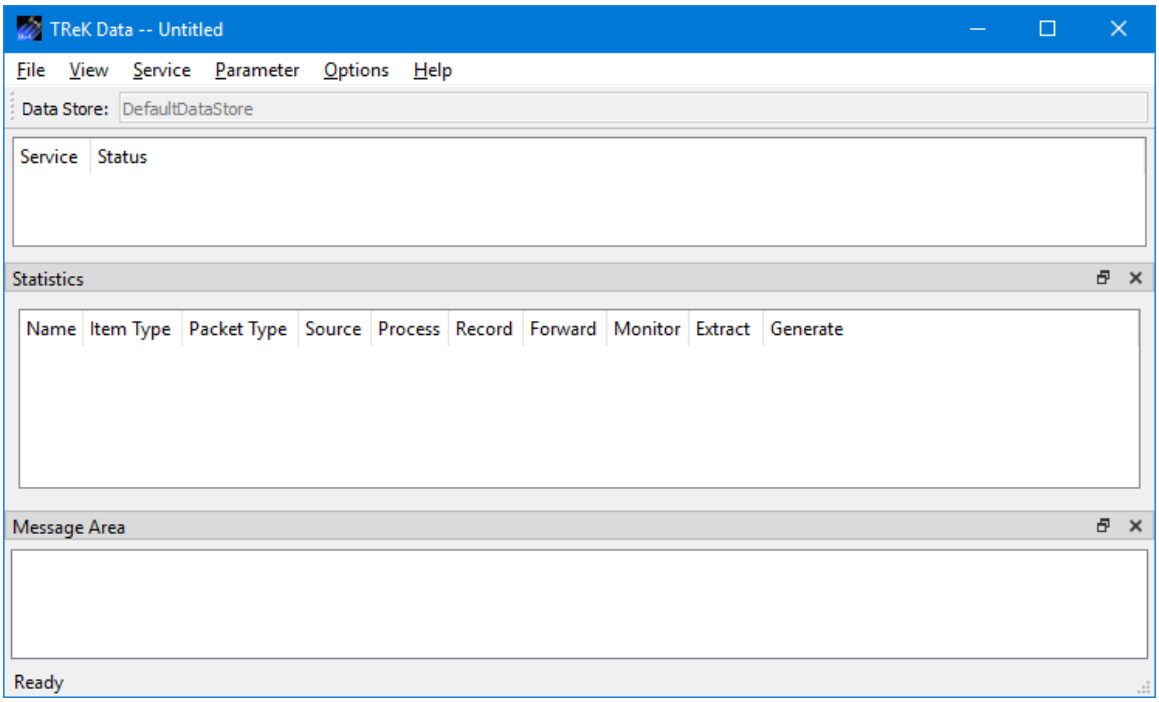

Figure 35 TReK Data Main Window

28. Go to the **Service** menu and select **Add Service**. You should see the dialog shown in Figure 36.

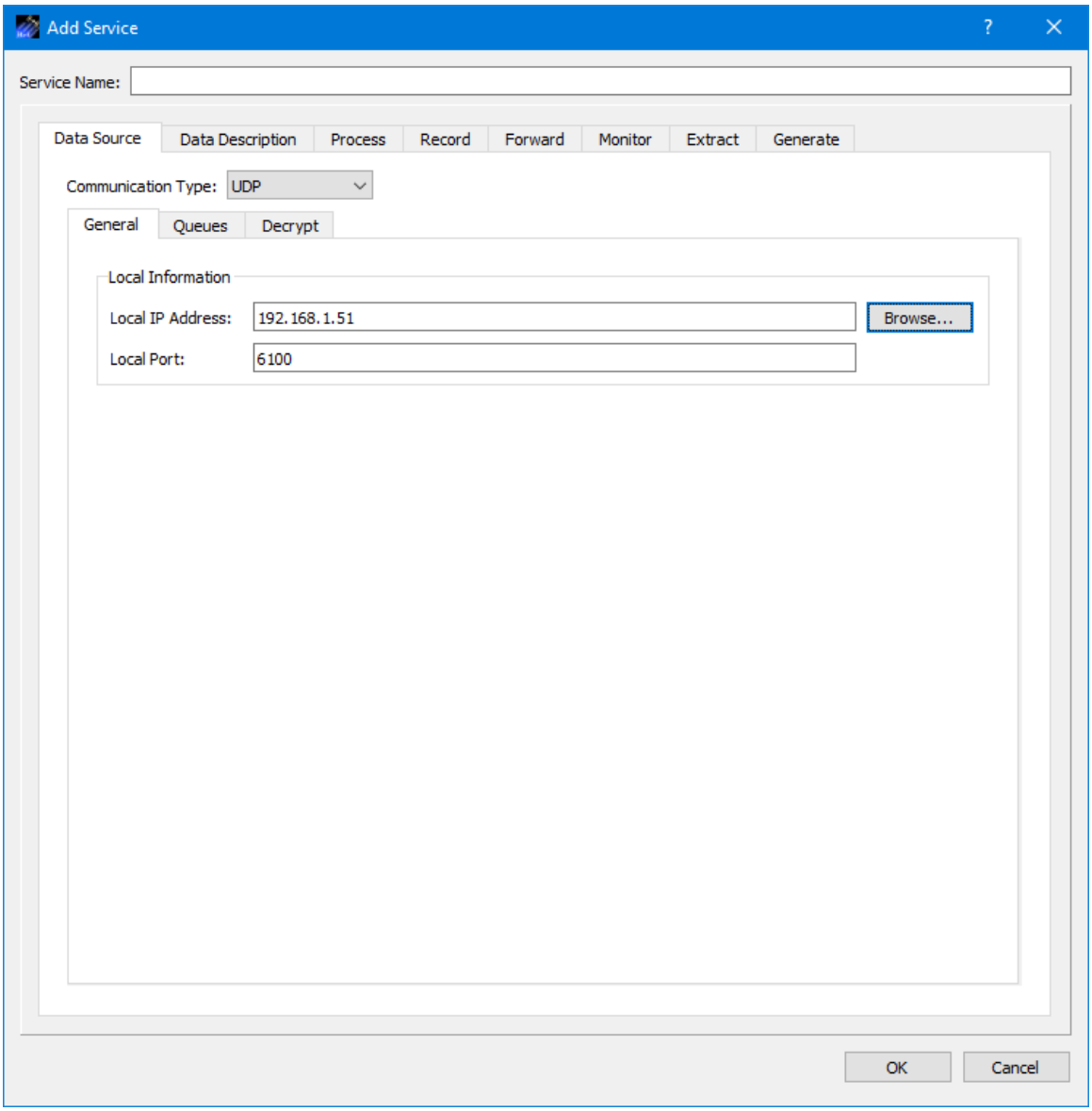

Figure 36 Add Service Dialog

29. In the **Add Service** dialog enter **Packet 314** in the **Service Name** field as shown in Figure 37. The **Local IP Address** should default to your local IP Address. But you need to check it to be sure. If it doesn't default to the right address, please enter your local IP address. All the other settings on this tab are set correctly.

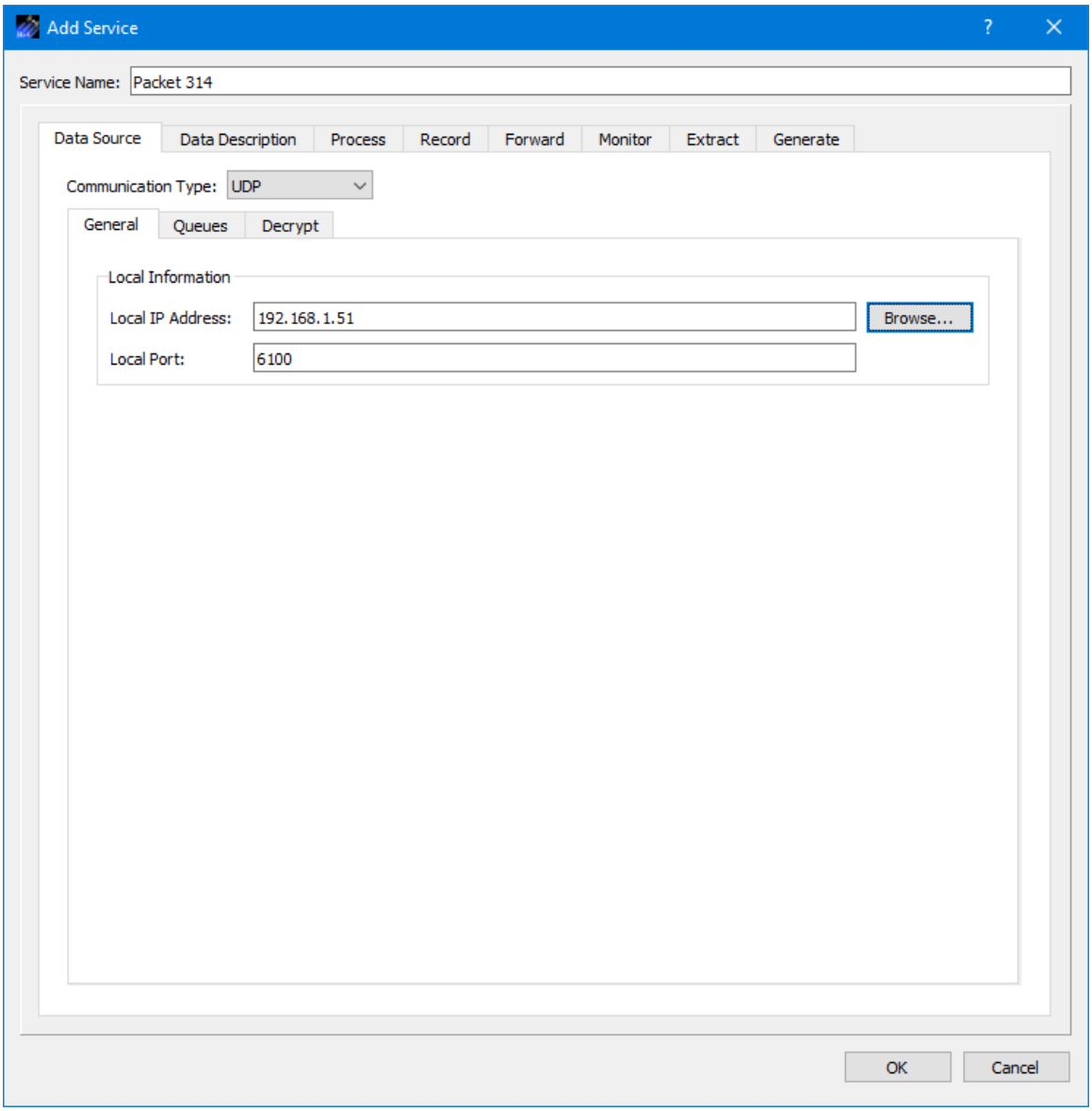

Figure 37 Service Name Populated

30. Go to the Data Description tab as shown in Figure 38. The Filter should be set to Packet List. Use the **Packet Type** menu to select **IssCcsds** as shown in Figure 39.

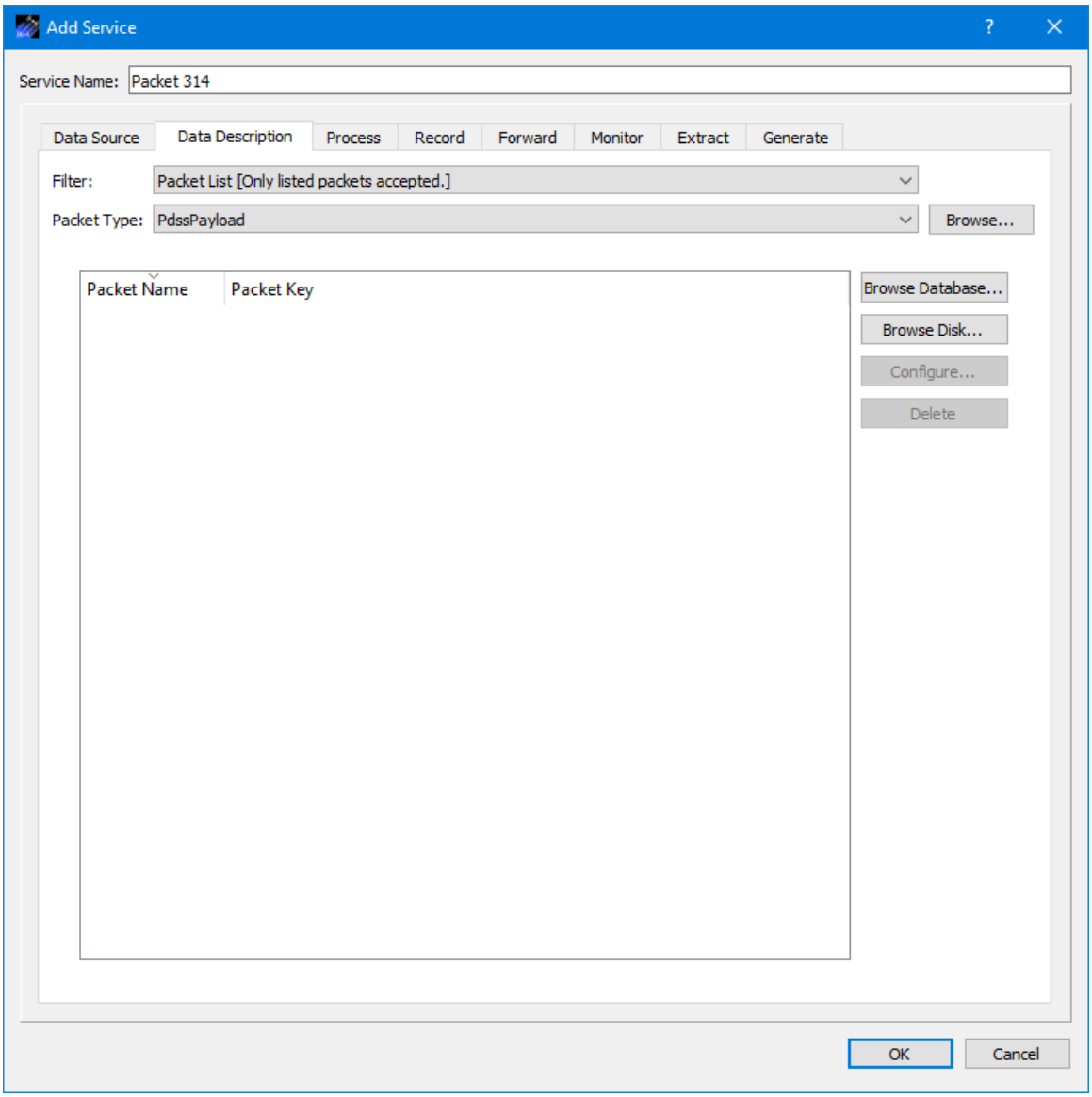

Figure 38 Add Service Dialog Data Description Tab

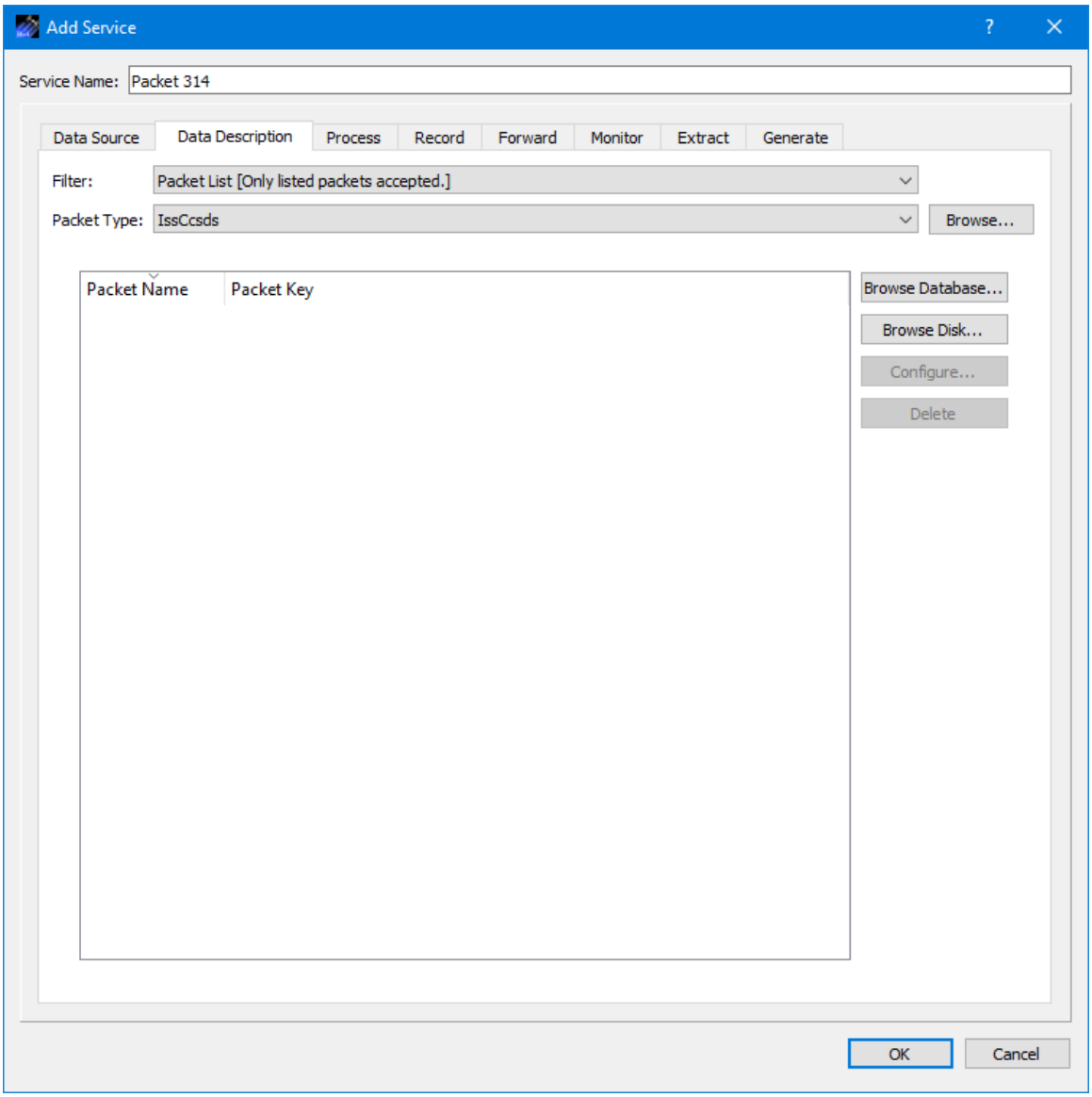

Figure 39 Packet Type Selection showing ISS CCSDS

31. On the Data Description tab push the Browse Disk button. In the Open dialog that is displayed select the Science Packet.xml file and push Open. This will add the packet to the packet list and your dialog should look like the one in Figure 40.

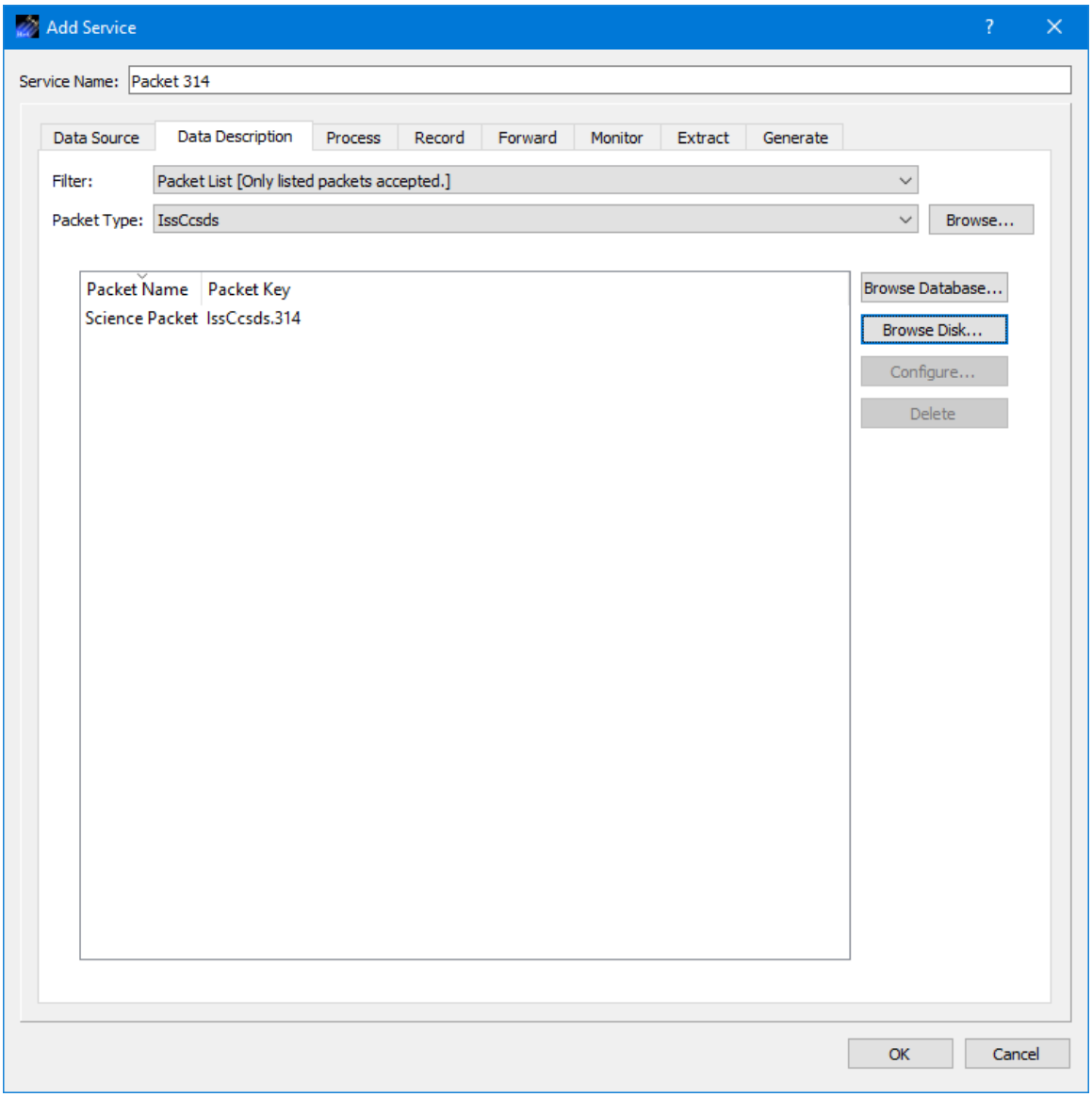

Figure 40 Science Packet in Packet List

32. Select the Process tab as shown in Figure 41.

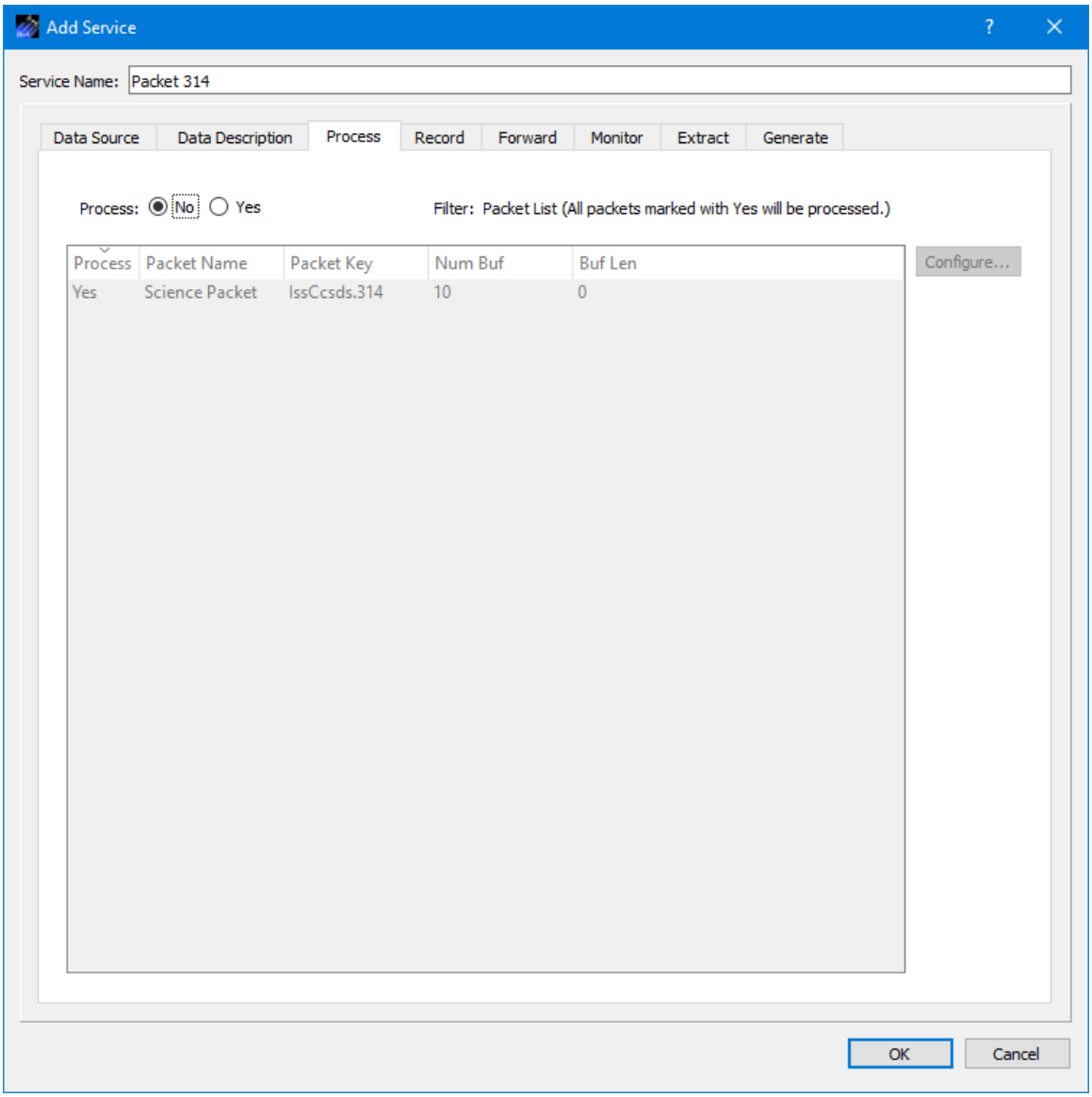

Figure 41 Process Tab

33. In the Process tab, select the Yes radio button to indicate you want to process data when it arrives as shown in Figure 42.

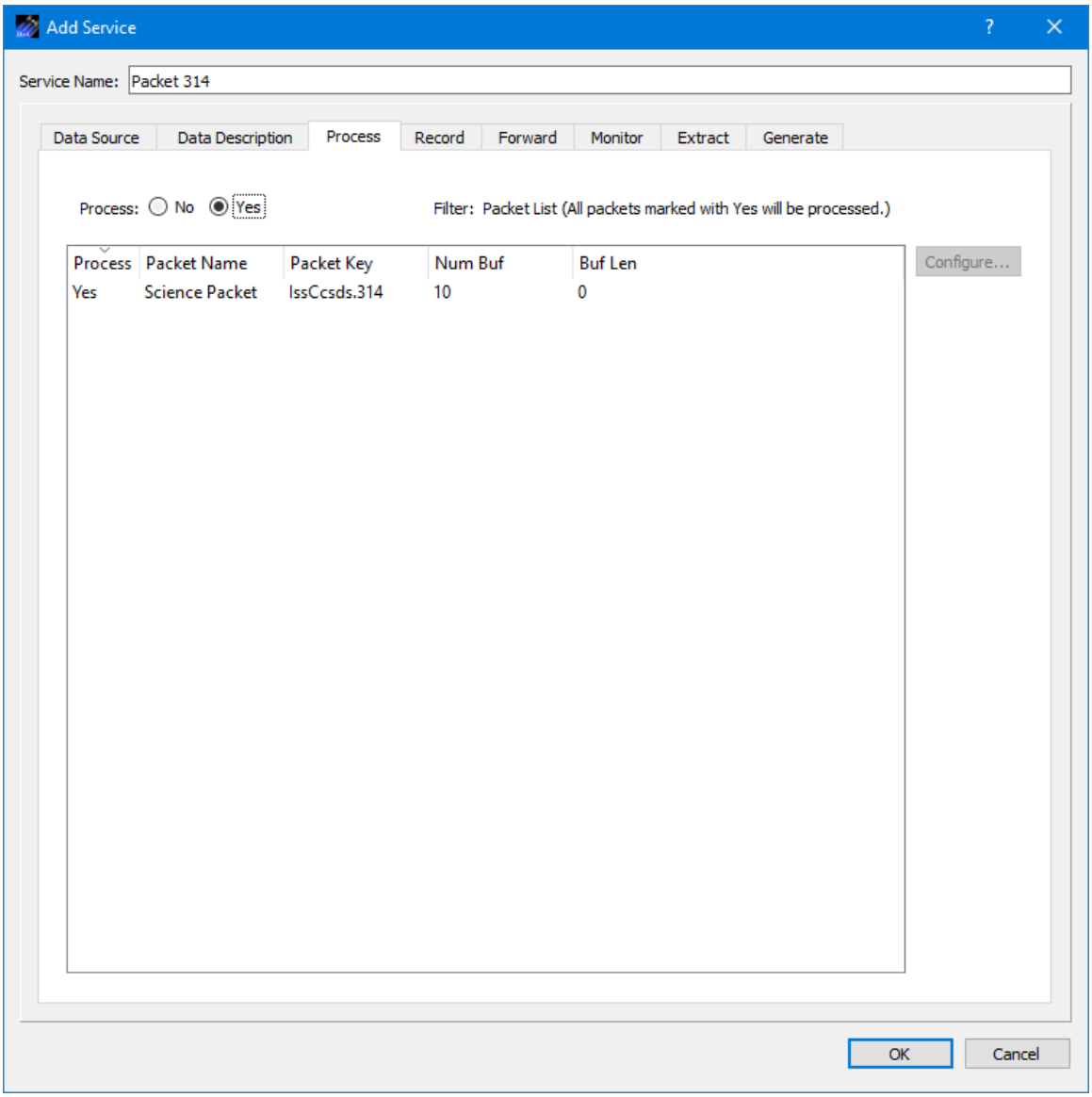

Figure 42 Process Tab with Process set to Yes

34. Push the OK button in the **Add Service** dialog to close the dialog.

35. Select Packet 314 in the Main Window as shown in Figure 43.

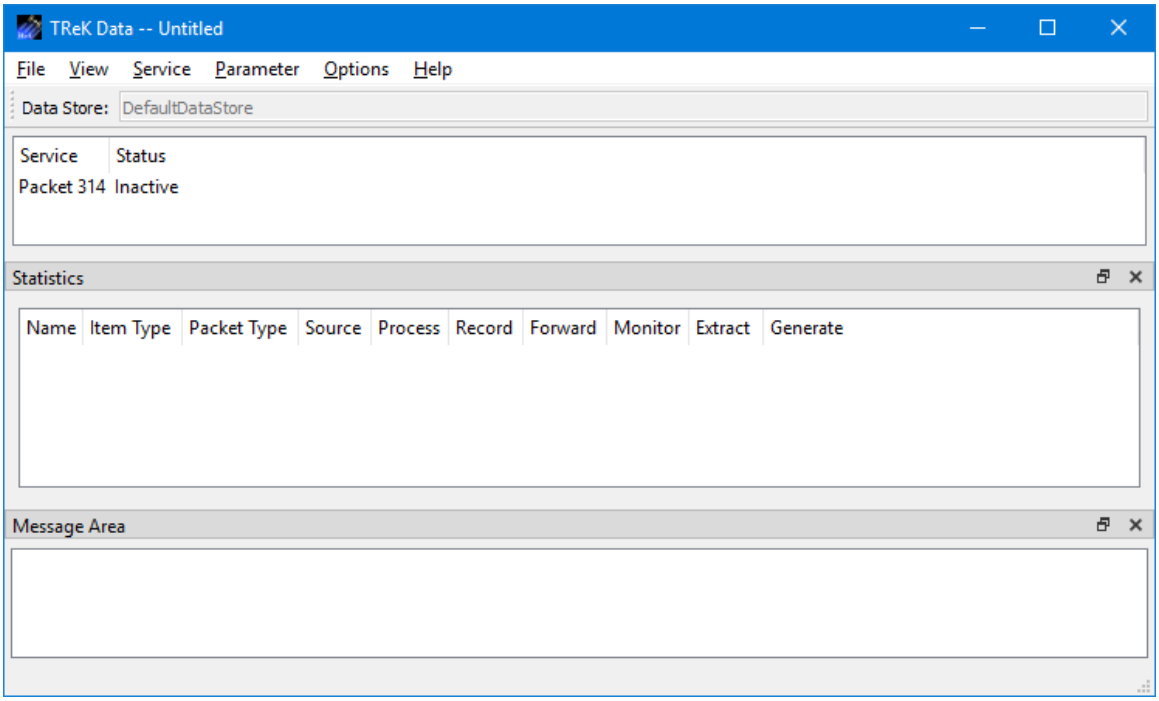

Figure 43 Packet 314 in the Data Main Window

36. With **Packet 314** selected, go to the **Service** menu and select **Activate Service**. Your Main Window should look like the one shown in Figure 44. Now you have everything configured to receive and process your packet.

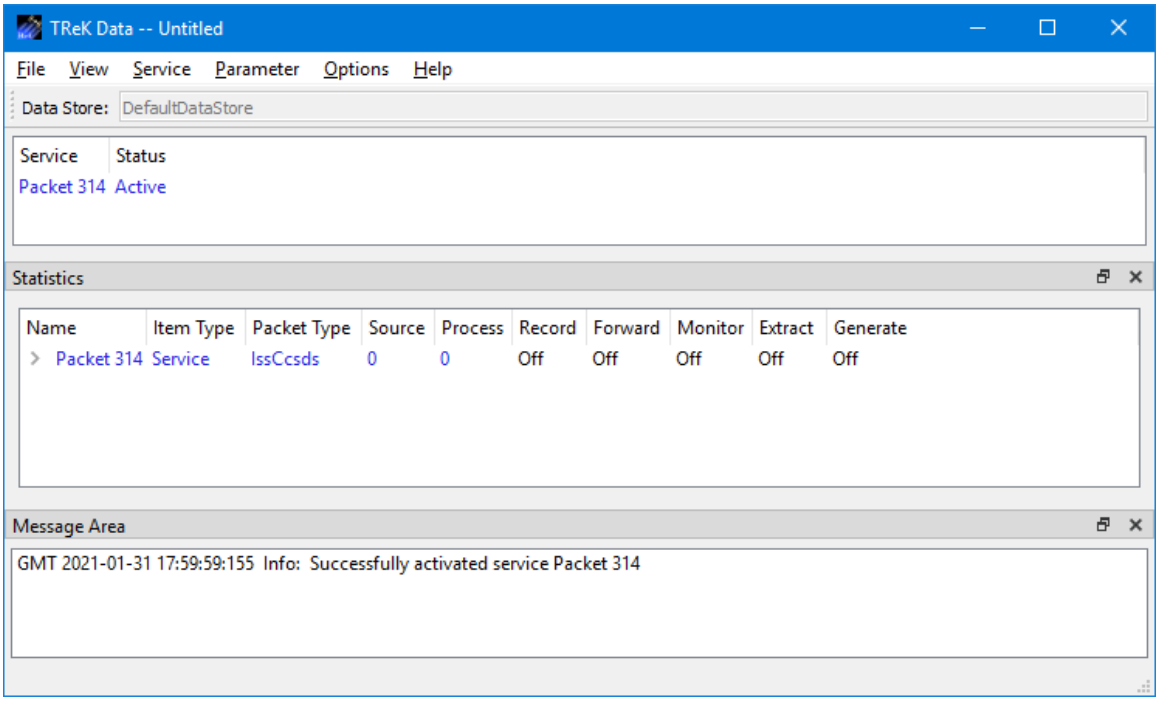

Figure 44 Packet 314 Activated

37. In the **Parameter** menu, select **Manage Displays**. You should see the dialog shown in Figure 45.

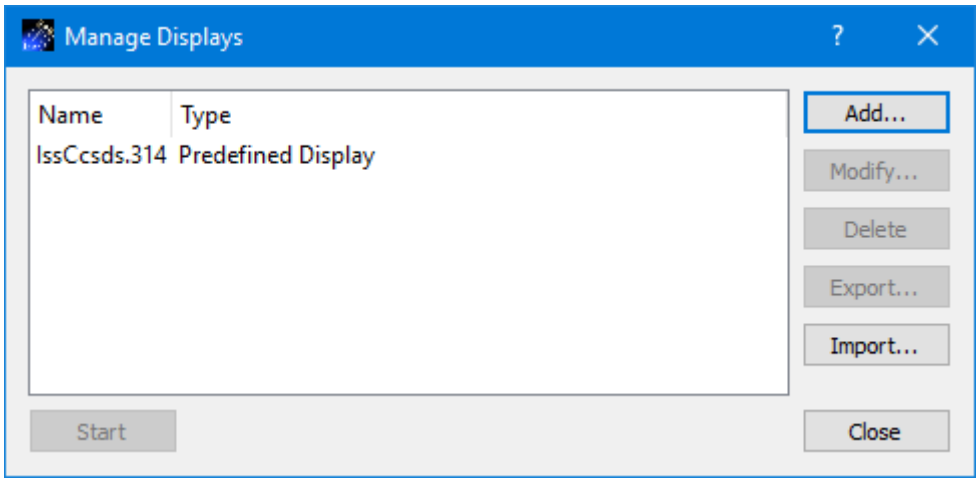

Figure 45 Displays Dialog

38. In the **Displays** dialog, select the **IssCcsds.314** display and push the **Start** button. You should see the dialog shown in Figure 46. Now you have a display to see the processed data each time a packet is received. The Value and Status columns are empty because you have not received any data.

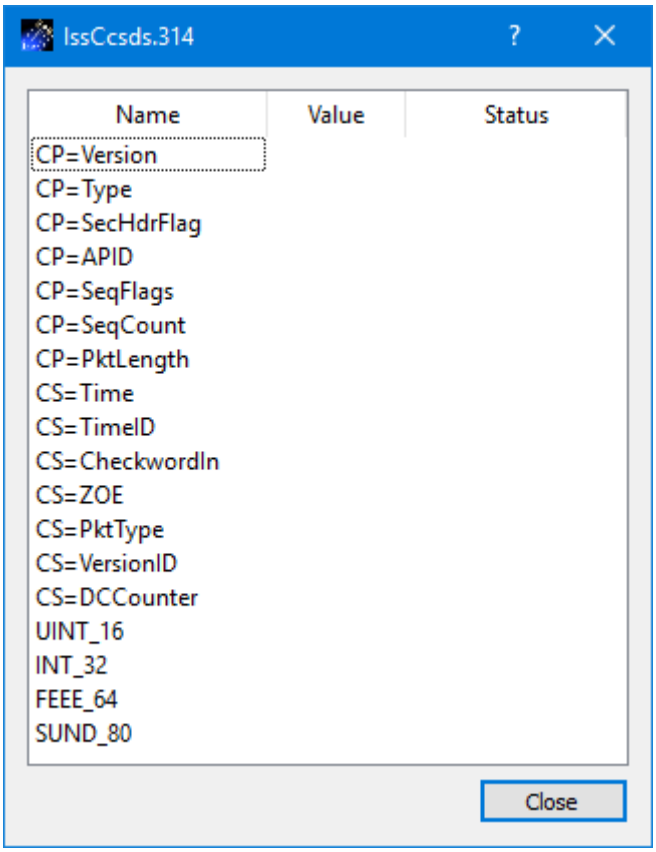

Figure 46 Science Packet Display

39. Now we need to flow some data. Go to the operating system's menu to start the **TReK Telemetry Trainer** application. This is an application in TReK Release 3.1.3. You should see the Telemetry Trainer Main Window shown in Figure 47.

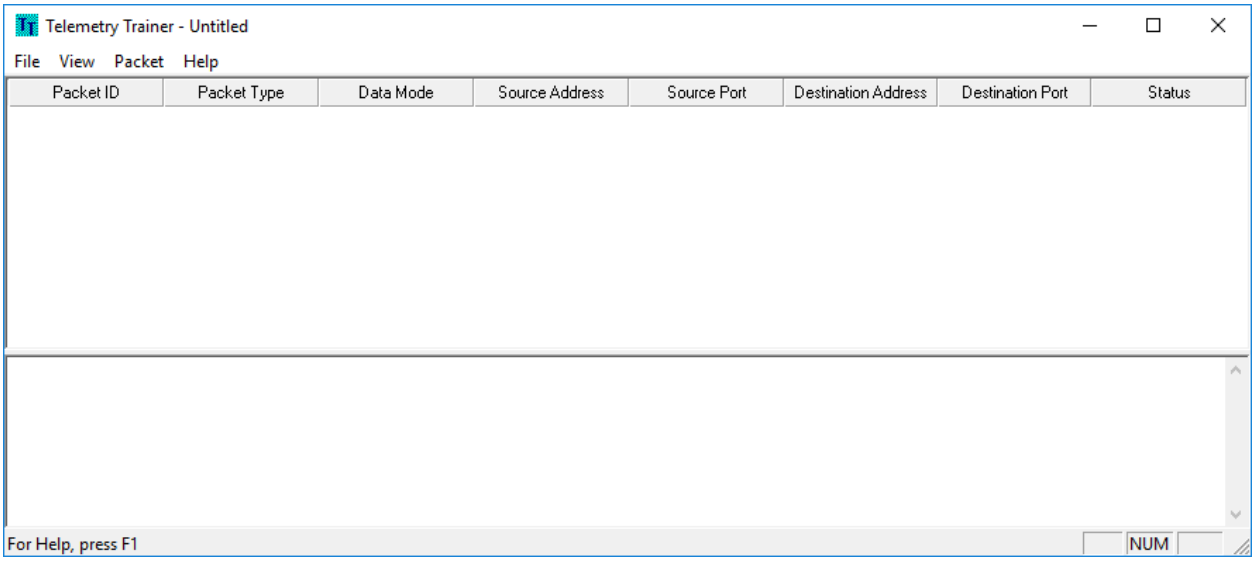

Figure 47 Telemetry Trainer Main Window

40. In the **Telemetry Trainer** application, go to the **Packet** menu and select **Add A Packet**. You should see the dialog shown in Figure 48.

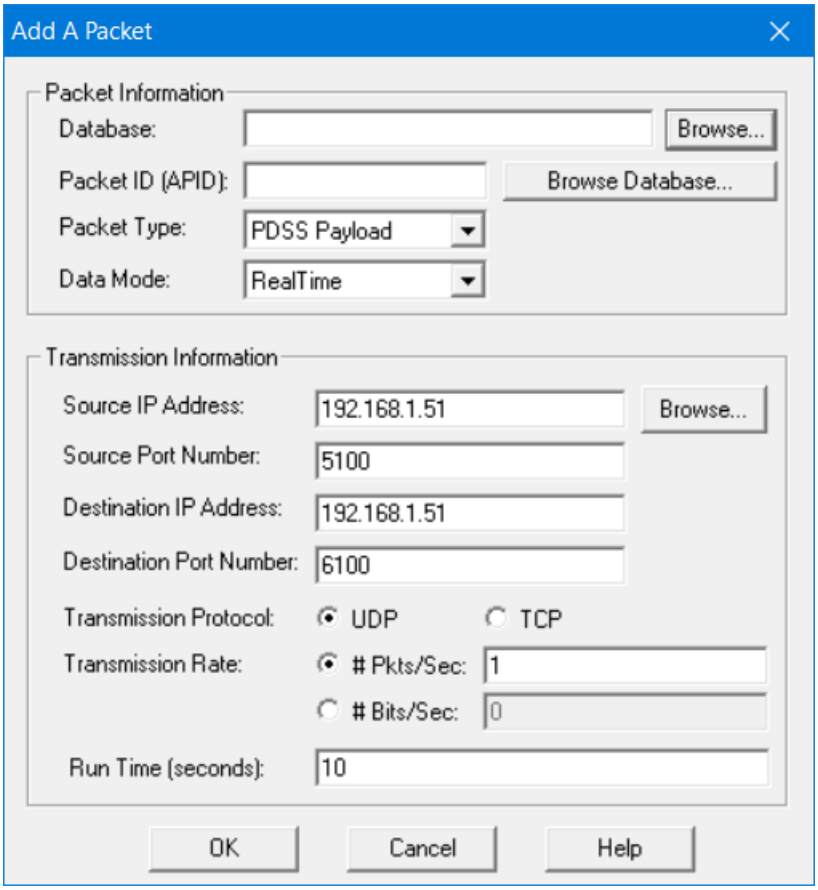

Figure 48 Telemetry Trainer Add A Packet Dialog

41. Enter the following values in the dialog:

Database	Browse to select the TelemetryDatabase.mdb delivered with TReK 3.1.3. (It must TReK 3.1.3).
Packet ID (APID)	314
Packet Type	CCSDS
Data Mode	None
Source IP Address	Enter your local IP Address.
Source Port Number	5100
Destination IP Address	Enter your local IP Address
Destination Port Number	6100
Transmission Protocol	UDP
Transmission Rate	# Pkts/Sec set to 1
Run Time (seconds)	100

42. Your dialog should look similar to the one shown in Figure 49. Please be sure the Source IP Address and Destination IP Address fields contain your local IP Address. Push the **OK** button to close the dialog. Your Main Window should look like the one shown in Figure 50.

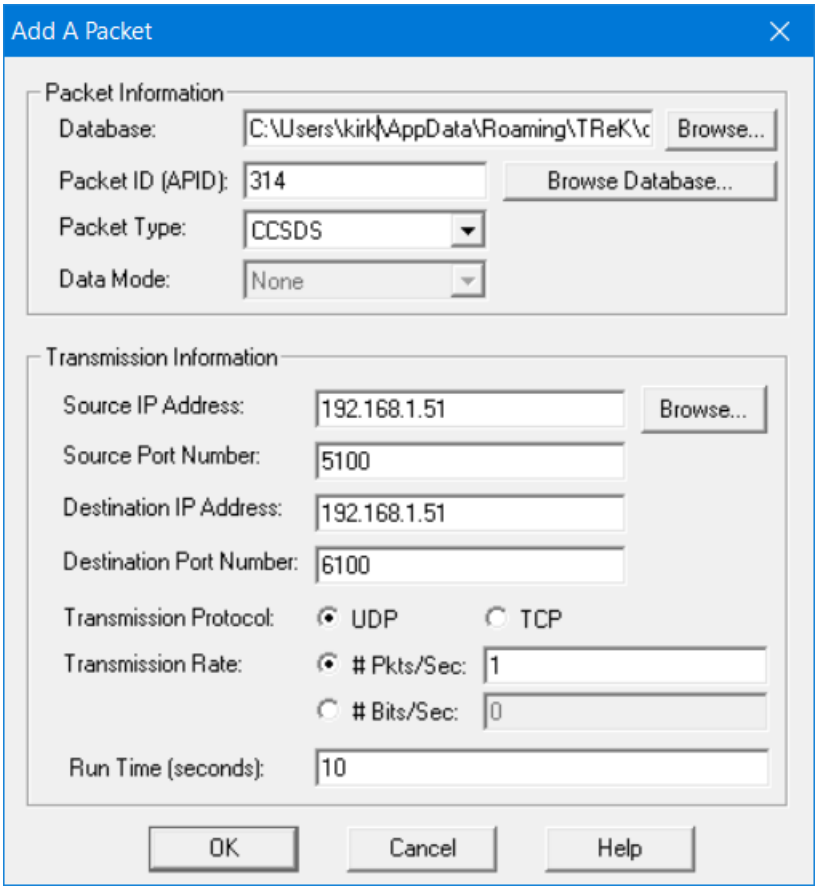

Figure 49 Telemetry Trainer Add A Packet Dialog

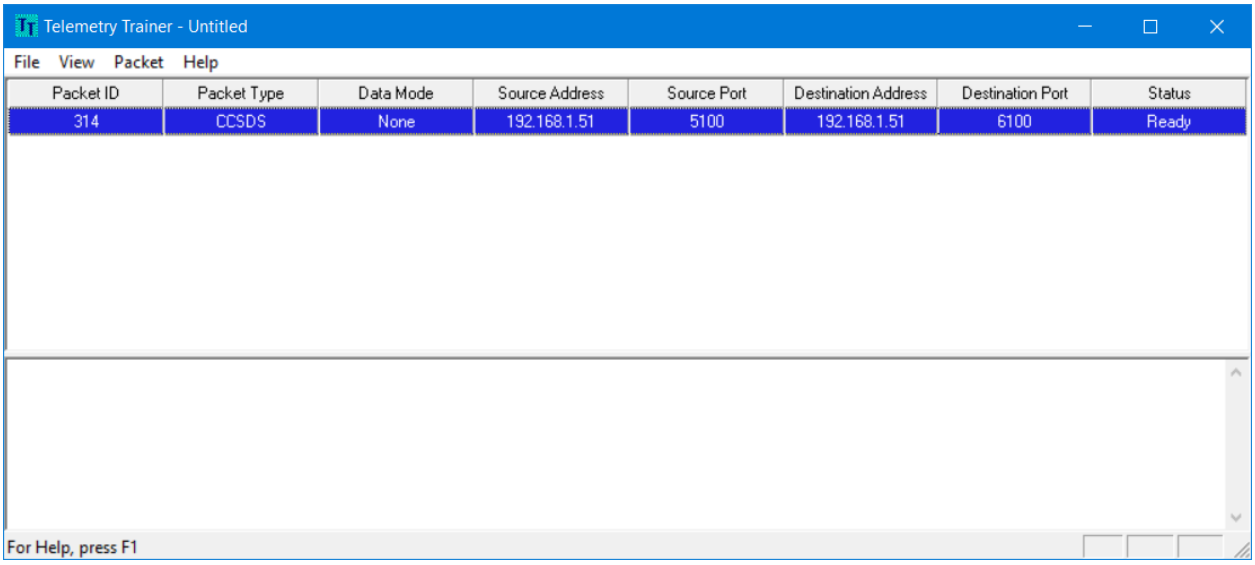

Figure 50 Telemetry Trainer with Packet 314

43. Now that you have identified the telemetry packet to send, you can start the data flow. In the Telemetry Trainer go to the **Packet** menu and select **Send Data**. The packet in the Telemetry Trainer will turn green to indicating it is generating Packet 314 as shown in Figure 51.

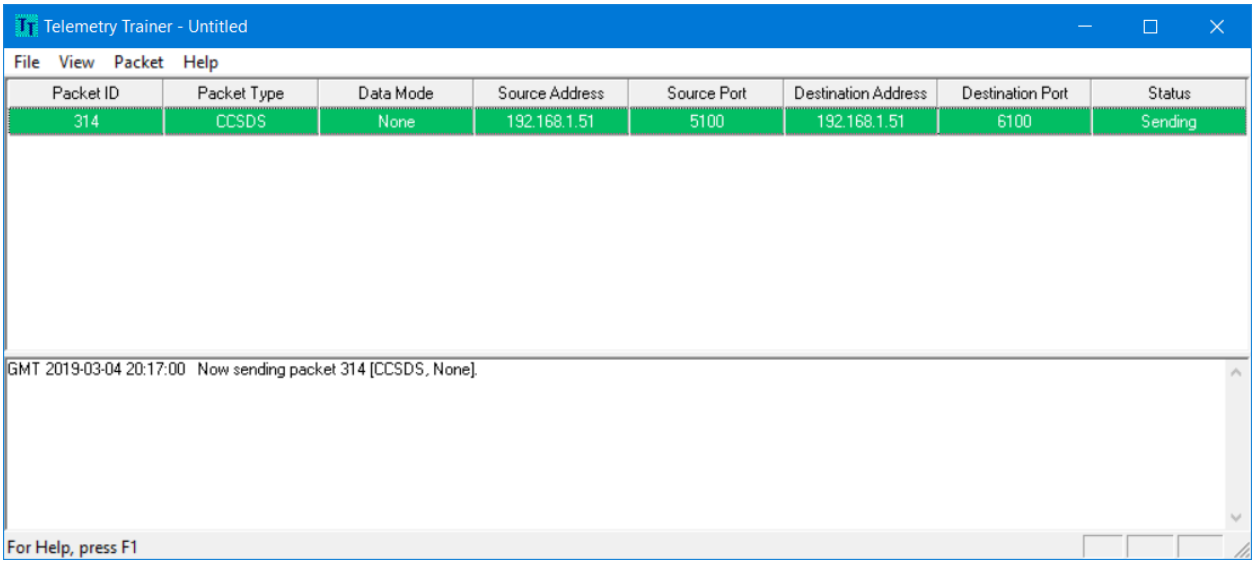

Figure 51 Telemetry Trainer Sending Packet 314

44. Look at the **TReK Data** Main Window. The service named **Packet 314** is green indicating it is receiving data as shown in Figure 52.

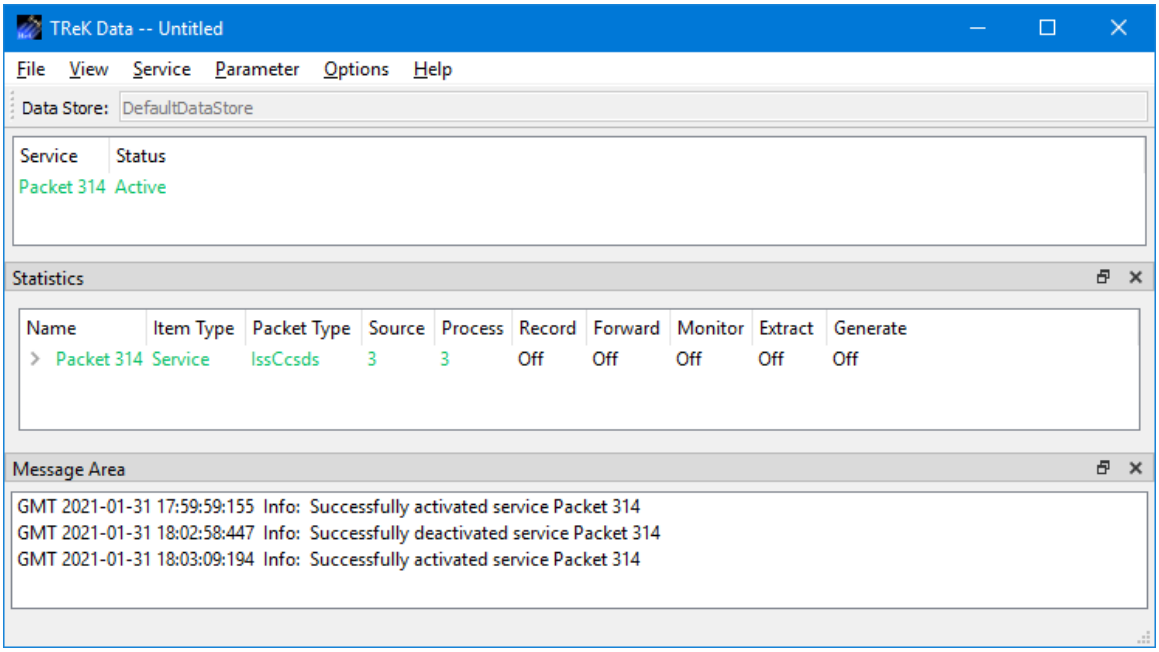

Figure 52 TReK Data Receiving Packet 314 Data

45. Look at the **IssCcsds.314** display. The **Value** column should contain data values as shown in Figure 53. The data value of each parameter in the packet is displayed on the **IssCcsds.314** display each time a new packet of data arrives and is processed by the TReK Data application. The Status column will be empty until there is status information to display.

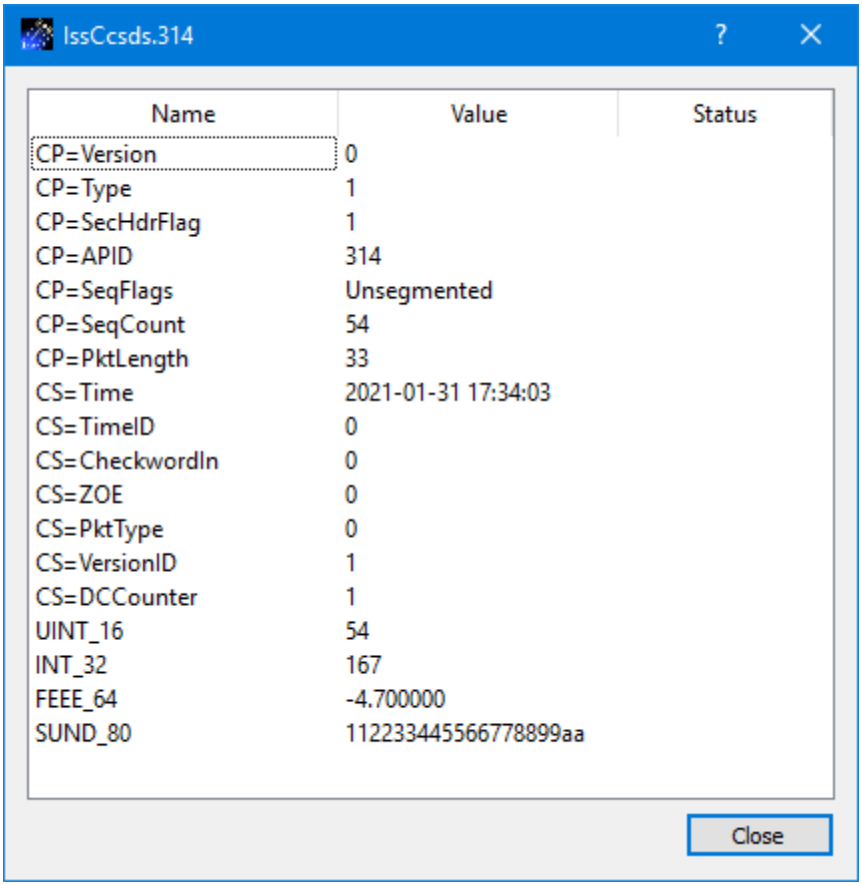

Figure 53 IssCcsds.314 Packet Data Values

Congratulations – you have successfully completed the Tutorial!